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SCIENTIFIC ORGANISATION AND MANAGEMENT

In a recent broadsheet, "Recruiting Civil Servants", Political and Economic Planning commented, as the Select Committee on National Expenditure has done, on the comparative weakness of the administrative class of the Civil Service on questions of organisation and management. The same question receives some attention in a report on the reform of the higher Civil Service prepared by a special committee of the Fabian Society; and the operation of the Division of Organisation and Methods in the Civil Service together with its effect on the staffing of Government Departments has been examined during the recent session by the Select Committee on Estimates. The fifth report of the latter Committee (H.M. Stationery Office, 1947. 4*s*. net) takes a fitting place with the sixteenth report of the Select Committee on National Expenditure for the session 1941–42, and indeed with the report of the Haldane Committee on the Machinery of Government; it merits close study at the present time in view of the bearing of this question on the most effective use of trained man-power.

From a wider point of view, however, these two recent reports are equally important. The report prepared for the Fabian Society reaches the general conclusion that since the Civil Service is now expected to provide for overall planning and the control and guidance of certain industries, the time has come to review and reform its methods of recruitment and training, its organisation and management. There are differences of opinion as to how far even a reformed Civil Service can be expected to be responsible for the conduct of industry, but there will be little dissent from the view that the new duties and responsibilities which it is legitimately and inevitably compelled to assume make imperative some fresh review of its structure, recruitment and training. That much is implied in the criticism of the Civil Service which is current; and a great merit of these reports is that they dispel much of the confusion and inaccuracy of such criticism and focus attention on the true defects, notably those arising out of its size and slowness, in a way that facilitates constructive proposals. Moreover, they bring into the open those other defects of the present organisation of government for the consequences of which the Civil Service itself has frequently been unjustly blamed.

The purpose of the Division of Organisation and Methods in the Civil Service is to secure maximum efficiency in the operation of the Government's executive machinery, and, by the expert application of scientific methods to organisation, to achieve economy in cost and labour. The Committee on Estimates quotes in its report from a striking speech of the Right Hon. R. C. Casey to the Institute of Industrial Management in Australia describing the results and methods of an organisation and methods investigation into the administration of Bengal. That investigation showed clearly and logically that the whole administrative machine in Bengal was fifty years out of date, and the Commission then recom-

mended how it could be brought up to date. That quotation alone indicates some of the possibilities, and the Select Committee on Estimates, in reviewing the Home Civil Service, points out that in view of the shortage of man-power and the increased participation of the central Government in economic and social affairs, it is imperative that specialized attention should be given to the adjustment and re-designing of the machinery of administration. The ideas of organisation and methods are not, of course, new; some were propounded by the MacDonnell Commission in 1914 and elaborated by the Haldane Committee and the Tomlin Commission. Nevertheless, it remains for effective use to be made of the recommendations of these bodies and the instrument already provided.

Pointing out that up to now the engineering and analytical approach of 'Organisation and Methods' has only been used to introduce simplification at lower levels, the Committee observes that it is at the higher level of the Government machine that defects may occur which will react throughout the Civil Service and cause wasted effort at each executive level. These defects can only be satisfactorily remedied by measures applied at the source. Moreover when, as at present, the activities of Government are altering rapidly, the whole pattern of administration has to be adjusted to meet the new requirements, and a distribution of duties according to function has become essential.

Little, however, has yet been done to apply such reorganisation at the top level as between different departments. What is needed is not a sporadic shifting of duties which may well result in equally bad overlapping elsewhere, but some modification of the present pattern of the administrative machine. That is already foreshadowed in the setting up of a single Ministry of Defence to co-ordinate the activities of the three Service Departments, and still more recently in the appointment of Sir Stafford Cripps as Chancellor of the Exchequer and Minister for Economic Affairs, and the establishment of a new ministerial committee on economic planning over which the Prime Minister will preside. The Lord President of the Council, it will be remembered, already exercises a considerable co-ordinating influence over the country's scientific effort.

Clearly, as the Select Committee recognizes, issues of constitutional importance are here involved, such as the limitation of departmental autonomy. While such issues can be dealt with only at the highest level, the Committee considers that it is a matter of urgency that these questions should be attacked scientifically and not as a series of piecemeal adjustments made whenever the strain on different parts of administration becomes intolerable. In such re-designing, the Division of Organisation and Methods should be planning the structure and machinery of Government rather than attending to its plumbing and maintenance. The Committee welcomes, therefore, the assurance that the Division is now being reinforced with a small group of officers who have already had some years of experience in considering machinery of government questions at a high level. Still more, it welcomes the establishment of a small committee consisting chiefly of permanent secretaries, with the head of the Treasury as probable chairman, and it suggests that this committee might be actively concerned with these alterations in structure which affect the whole Civil Service, provided the committee meets regularly and is strengthened by experts on administration from outside the Service where necessary.

These, in fact, may well be the most important recommendations of this searching report. If industry is to be urged to become more efficient, the Government must put its own administration in order. Insufficient thought has been given to adapting the machinery of government to its new tasks, as *Planning* has repeatedly urged.

This is not the greatest danger. As the Select Committee notes, although some new ministries have been formed and much of the responsibility for the actual conduct of industrial and trading activities is being placed in the hands of quasi-Government boards, the size of the major Departments of State has of necessity much increased. The danger is that these may have become too large and cumbrous to work rapidly and efficiently as single administrative units. Redistribution of functions between existing departments might not, indeed, effect any striking economy in man-power; but a reconsideration of the whole pattern of the Government machine in the light of modern conditions might well suggest a reorganisation that would increase the rapidity and efficiency with which the ever-growing volume of work is discharged. Even if this did not reduce staff, it might obviate further increases and in that way prove true economy.

Nor is this all. A pattern has to be worked out by which the new national boards and other like public corporations which have responsibilities to the State can be incorporated in, or satisfactorily linked to, the administrative machine. Neither in man-power nor in finance can efficiency be secured unless the problem is viewed as a whole, and the task must be attempted by some body equipped for the purpose. The Civil Service has proved itself to be an adaptable organisation, and this valuable characteristic must be preserved in any new alignments.

A review at the highest level during the interval before the planned reviews by 'Organisation and Methods' staffs can be put in operation is suggested as advantageous by the Select Committee. It might well indicate the need for substantial readjustments, and these may affect organisation at lower levels. This is the real reason why the Select Committee is so firm in its view that there must be something much more than the extension of 'Organisation and Methods' work as seen in the past. There must be no more tinkering with the problem, but a thorough and careful scrutiny of the government machine as a task demanding the highest priority among the many demanding attention.

Strong support for this view is to be found in the report from the Fabian Society's Committee, in Mr. L. S. Amery's recent book "Thoughts on the Constitution" and in a recent article by Lord Samuel.

The latter, in suggesting a Cabinet of ten with a tentative grouping of departmental Ministers in five groups, urges that the time is ripe for a fundamental reform. Recent changes, he holds, have made little difference to the old system, and he suggests that by conferring wide powers on each of these groups, the chairman of each remaining responsible to the Cabinet for its proceedings, with the right to reserve for Cabinet decision matters of general concern or likely to give rise to controversy, or where there had been a serious difference of opinion, the groups might develop distinct individualities while preserving the elasticity which is so excellent a feature of the British constitution.

The Fabian Society's Committee covers a wider field, including within its survey besides questions of organisation those of Parliamentary and financial control as well as control of personnel, but is rarely so fundamental as the Select Committee. Its recommendations on 'Organisation and Methods' do not go much beyond the tinkering which the Select Committee deprecates. It suggests, for example, an Organisation and Methods Committee with qualifications to work out the best office procedure and with powers to impose it on all Departments, but it views organisation and efficiency here rather from the mechanical point of view. Even although it recognizes that the proper functioning of public boards controlling nationalized industries demands freedom and flexibility of action, and that control should not extend beyond matters of policy, it gives little clear guidance as to how such bodies are to be related effectively to the national administration. It recommends that public boards should be linked to the parent departments by small policy-forming bodies in the latter, while unnationalized industry should be guided by controls set up and disbanded as occasion requires on the lines of war-time experience.

While recognizing that for many problems, particularly short-term ones, inter-departmental committees provide the only means of handling problems affecting many departments, the Fabian Committee advocates the extension to the civil sphere of the Joint Staff Committee system, particularly in such fields as central economic planning, building and the supply of fuel and power. It visualizes a standing high-level committee of the permanent heads or appropriate senior officials of departments which are constantly engaged upon some joint activity, and under the general direction of a ministerial body, analogous to the Defence Committee. There should be in each department concerned a central planning organisation, and the Joint Staff Committee should consist of members of the departmental planning organisation, but detached for joint work, and the planning staff should be responsible both for making the plans and for seeing them executed. These planning staffs should be served by a central secretariat—part of the Cabinet secretariat—a vital responsibility of such a secretariat being interpretation.

The Fabian Society's Committee is under no illusions as to the effect of these recommendations in increasing the demand for senior Civil servants, and one of its recommendations is for the immediate admission to the administrative class of a further hundred recruits between the ages of thirty and forty-five. It is much less realistic than the Select Committee, or indeed than a group of Conservatives which put forward proposals for constitutional reform last year, in regard to what is possible with the limited resources of trained man-power in Britain.

There are sensible recommendations regarding leave, entertainment allowances, and amenities for senior officials, but the most interesting feature of this section of the report is the discussion of the relation of the administrative class to the professional, scientific and technical classes. It concludes that civil departments still too often ignore the help which scientific workers could give them on broad questions of policy as well as on technical matters, while the scientific specialists often make little effort to brief administrators properly on technical questions; there is the same lack of co-operation between the administrative class and the professionals. The two essential problems in developing satisfactory relations are to ensure that adequate use is made of specialists both in technical matters and in matters of broader policy, and in preventing the experts from seeing questions exclusively through technical spectacles.

Specific recommendations are on the familiar lines of transfer from the scientific and professional to the administrative class being facilitated, the improvement of pay and status of the former relative to latter, and encouraging mobility of scientific men and professional workers between the Civil Service and universities, industry and other outside employment. Beyond this it is suggested that departments should devise methods of keeping their scientific men and other professional workers informed, and consulting them at an early stage. It is also believed that there is scope for the new technique of operational research in civil departments, and that it could be used in public corporations to measure the value and efficiency of services to the public which can no longer be evaluated in terms of profits to the shareholders.

The Fabian Society's Committee is here on more debatable ground, and the issues are by no means clearly thought out; nor does the report show any clear conception of what is understood by operational research. Fundamentally, it is no more than scientific management properly understood, and from one point of view the use of the term 'research' is perhaps unfortunate and a misnomer. It is implicit in the suggestion, however, that the civil departments are not making sufficient use of the experts at their disposal; and as was brought out in the discussion at Dundee, notably in a contribution by Sir Robert Watson-Watt, operational research is here understood as a renewed attempt to solve the problem of the right relations of the administrator and the expert and the effective use of knowledge in the solution of social and economic problems.

Many of the suggestions put forward by Mr. Amery in his book referred to above are parallel

with those made in the reports already noted. By reform and example at the top, he hopes to secure a real co-ordination of the work of departments in the light of coherent policies thought out beforehand, and to eliminate the extemporization and weak compromises which so often result from the attempt to reconcile conflicting departmental policies as and when a problem has obtruded itself on the attention of an overworked Cabinet. Incidentally, while Mr. Amery appreciates the need to encourage the creative and constructive side of the work of the Civil Service, he recognizes that departments have not been so lacking in initiative and creative thought as is sometimes suggested. He is severest on the Treasury, and insists particularly on the need for co-ordination here, as does the Fabian Society's report. That constructive criticism from such varied quarters should issue in such similar proposals should not be overlooked by those who, independent of party politics, are concerned to preserve our great heritage of freedom and adapt it to the needs of the present, having regard both to the new burdens and tasks of Government and to the dangers inherent in the neglect to keep the spirit rather than the letter of the constitution. It is to such criticism that we must look in approaching the general task of increasing the efficiency while decreasing the cost of government; by this means proposals for reorganisation may be forthcoming which will enable Government from the Cabinet downwards to cope effectively with the tasks which face it to-day.

PEOPLES OF THE INDIAN ARCHIPELAGO

The Peoples of Malaysia

By Fay-Cooper Cole. Pp. xiv + 354 + 37 plates. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1945.) 22*s*. net.

PROF. COLE has aimed at giving, in a comparatively small volume, a conspectus of the extremely varied peoples of Malay affinities, at every stage of culture from that of the primitive food collector of Malayan jungles to the civilized inhabitant of Manilla or Batavia, who inhabit the Indian archipelago. The author postulates an underlying unity of culture multifariously and unevenly affected by various intrusive elements, and accounts for it convincingly by pointing out the way in which the courses of the great rivers of south-east Asia afford a number of extremely divergent outlets to the sea from the comparatively confined area of the sources of the Brahmaputra, Salween, Mekong and Yangtze. In the prolonged and diverse courses of their journeys to the islands, the various branches of the mongoloid stock from which the Malays spring have been subjected to very varied influences, and have received yet more and stronger ones after reaching their island homes. The great diversity that has resulted from this is illustrated by a series of accounts of different tribes chosen from various grades of culture and including tribes of Australoid and of negrito affinities which seem to have preceded the Malayan elements. These accounts are inevitably generalized, and are not all based on personal observation and knowledge, though the author's personal experience of the Indian Archipelago is obviously wide.

In such an account it is almost inevitable that there should be some inaccuracies and occasional dubieties, and while they detract little from the value of this admirable general account of the Malayan peoples, it is probably worth while directing attention to certain of them. Thus the author's general judgment on the problem of negrito variations is obviously sound, but he is very much out of date in putting the total of the Andamanese at 2,000. The number was a little less than that in 1901, and there were only 460 left in 1931. In the Census Report of 1941, the Andamanese do not seem to be mentioned at all. Prof. Cole suggests (p. 89) that the pygmies of Malaysia are unable to swim; but I have seen Andamanese swimming round and under a harpooned but very active dugong some 9 ft. long to rope its flukes to its sides by slipping nooses over its head. The Jakun are mentioned as using a blowgun "artificially bored as in Borneo". It should be made clear that they do not make it themselves; it has always been imported for them from Borneo.

Prof. Cole suggests that the Punans of central Borneo do not exist as a distinct people, but are merely parties of temporary nomads who have been mistaken for such. In view of the circumstantial and detailed accounts of Punans both by Haddon, and by Hose, who lived some twenty-five years in Sarawak, this suggestion seems almost frivolous, particularly in view of Prof. Cole's own statement as to want of knowledge of central Borneo. The suggestion (p. 211) that the long house is "a development from the widespread unit dwelling" may conceivably hold good for the Tinguian, but in many cases it is more likely that the development has been the other way, and that the long house has devolved into a narrow street of separate houses with the bachelors' communal house surviving as a separate building at one end. Indeed, intermediate stages in such a development have been observed in New Guinea.

The effect of contacts with Malaysia from India have perhaps not been entirely understood, for they must have started at a considerably earlier date than the development of Brahmanism; and on the other hand, there are indications of some very early development and dispersion of culture from a centre in the archipelago which possibly carried items of culture like households of the Menangkabau far afield to Assam and Madagascar. The ancient bronze 'kettledrums' of the Karens, of Siam, and of Cochin China have likewise been ascribed by some authorities to an island source, such as may have also been responsible for the great monolithic burial urns of Cochin China, Sumatra and Assam. Had the author cast his net wider than Malaysia, he would have found an even closer correspondence of cultural features widely spread in south-east Asia (and beyond it) than he himself suggests.

It remains to add that Prof. Cole criticizes severely the nature and effects of British Colonial policy in Malaya, contrasting it, much to its disadvantage, with the policy of American administrators and Roman Catholic missionaries. It would, we think, be possible to present a very different picture of the results of American policy in the Philippines without any greater departure from objectivity. There are several misprints, and the illustrations are poorer than we have learned to expect from American publications of this class.

J. H. HUTTON

SCIENCE AND PEACE

Science, Liberty and Peace
By Aldous Huxley. Pp. 64. (London: Chatto and Windus, 1947.) 3*s*. 6*d*. net.

WITHIN the limits of the present slender volume it would be manifestly absurd to expect a profound contribution to thought on the great issues named in its title. Nevertheless, while displaying once more the intellectual reaction against nineteenth-century faith in the capacity of science to improve human society which characterizes his philosophical writings, Mr. Huxley sets forth clearly the inter-relations between science, liberty and peace. The two essays of which the book consists make no claims to originality of thought, and it is easy to recognize the influence on Mr. Huxley's thinking of A. N. Whitehead, Louis Mumford, Karl Mannheim, E. H. Carr, Lord Lindsay and others. The slenderness of the volume should not, however, have prevented the inclusion of at least some references which would help the reader who is interested to explore further sources on which, consciously or subconsciously, Mr. Huxley has drawn.

Mr. Huxley concludes his book by commending Dr. Gene Weltfist's suggestion in the *Scientific Monthly* (September 1945) that technicians and men of science should take a professional oath similar to that of Hippocrates, pledging themselves to use their knowledge for the good of humanity and against the destructive forces of the world, and to work for such common ends with their fellow scientific workers of whatever nation, creed or colour, and he is presumably addressing himself primarily to the man of science and technician. It is not otherwise easy to discover either his purpose or the type of reader for whom the book is intended. For the general reader the argument is scarcely simplified enough. His main point regarding the small community, with the suggestion that science will assist us to solve the problem of power by devising methods to enable small communities to be self-sufficient in such matters as food supply and power, which is the essential contribution of the book, might well have been made clearer by using the Tennessee Valley Authority as illustration in greater detail. Had he done so he could scarcely have made the assumption that the 'integration' of a scientific and political approach involves the imposition of something from above and not the organic union and harmony of functions which McCurdy had in mind in discussing the problems of social organisation. Mr. Huxley criticizes rather obliquely the theme Col. Urwick developed in an address on "Compromise and Integration"; but it is difficult to believe that he has read either that or Lilienthal on the Tennessee Valley Authority.

Like so many others Mr. Huxley is better at diagnosis than prescription. He stresses rightly the immense power which science and technology have put into the hands of those who control the modern State, and he infers that if resistance is to be offered by the many to the few it must be in a field in which technological superiority does not count. But his defence of passive resistance is as naïve as his argument that it has never been tried is historically unsound. Again, while he recognizes the economic and social security which technological progress has brought, and although he pleads for the help of religion and for a moral basis for world order, he does not show the same awareness of the moral disintegration which Duckheim stressed or of the power of a moral tradition as the only effective brake on misgovernment.

These lapses and omissions detract from what is none the less an interesting and suggestive, if scarcely persuasive, book. Mr. Huxley, in truth, is too faint-hearted an advocate. He can see through many of the illusions of his time and, indeed, over-simplifies the issues. Even his argument for decentralization and development of the autonomous groups is advanced without much clear confidence that the man of science and technician will heed the summons to co-operate. Mr. Huxley sees clearly enough the implications for individual freedom of the concentration of power in ever fewer hands; but the argument for decentralization could have been strengthened had he analysed more fully or philosophically the idea of freedom. Recognizing that science and technology have changed the basic postulates of thought and that the scientific picture of the world is inadequate because science only deals with certain aspects of experience in certain contexts, he urges the study of philosophy by the man of science and technician, and that ministers of religion should teach a new doctrine of the Final End of Man rather more nebulous than that according to the Shorter Catechism.

If Mr. Huxley's remedies seem to be over-simple they are not necessarily invalid so far as they go, and this plea for a re-statement of the Emersonian doctrine of self-reliance with particular reference to the techniques available for achieving independence within a localized, co-operative community is pressed as the means of securing the abolition or elimination of war, in spite of the opposition from Governments which anything like a popular movement would encounter. Mr. Huxley suggests that as individuals or in organised groups scientific workers can help in three ways. First, and negatively, they should consider the problem of right livelihood in its relation to their own contemporary activities, and they should seek answers to these questions on the level of their international organisations. Next, he suggests tentatively the exploration in a wider field of the plans for an international inspectorate already outlined in regard to the atomic bomb and the pooling of all scientific discoveries considered by competent experts to be even potentially dangerous to mankind.

Scepticism as to the value of such safeguards will not be diminished either by the publication of the new Russian law classifying as State secrets research and experimental work in all branches of science and technology or by the exclusion of atomic energy from the discussions at the recent International Congress of Pure and Applied Chemistry. Mr. Huxley looks more hopefully to action initiated in the scientific field and ending in the political. The planning of scientific activity for predetermined political, social and economic ends must begin where the results of disinterested research—which itself cannot, he observes, be planned more than to the extent of subsidizing inquiry into neglected branches of knowledge—are applied to the solution of practical problems. Individually and through their professional organisations men of science and technicians could, he maintains, do much to direct planning towards humane and reasonable ends. Further, he thinks it possible, if not essential, for technicians and men of science to adopt a professional policy, consciously and deliberately designed to serve fundamental human needs and to forward the causes of peace and personal liberty.

That, indeed, might fairly be described as the purpose of the Atomic Scientists' Association; but Mr. Huxley insists that only an international organisation of men of science could work out such a policy in detail. Tentatively he indicates what such a policy would include: a world-wide campaign for greater food production, including regional self-sufficiency in food production, and, scarcely less important, self-sufficiency in power for industry, agriculture and transport. On the technical implications of such a policy he does not enlarge, although he notes that the storage as well as the production of power has to be considered, but expresses the opinion that atomic energy is, and for a long time is likely to remain, a source of industrial power that is politically and humanly speaking in the highest degree undesirable.

Mr. Huxley has ideas and suggestions that merit discussion, but whether this book of itself will stimulate such debate is doubtful. It lacks the conviction that compels to action. The critic who shatters illusions remains too much the sceptic to be the prophet or apostle of a crusade to overthrow the tyranny of which he complains and build a new world in which science will be free and used for peace.

R. BRIGHTMAN

PALÆOBOTANY FOR EVERYMAN

Ancient Plants and the World they Lived In

By Assoc. Prof. Henry N. Andrews, Jr. Pp. ix+279. (Ithaca, N.Y.: Comstock Publishing Co., Inc.; London: Constable and Co., Ltd., 1947.) 25*s*. net.

THIS book is an attempt, and a very successful attempt, to convey to the general reader an idea of the vegetation of the earth in ages long past and the indications it may give of the climates of those times. From a study of their fossil remains so many details are now known about extinct plants that it is no easy task to give a convincing description of what the vegetation was like without becoming involved in highly technical descriptions of many individual plants. The author has shown admirable discrimination in his choice of examples, and gives a clear picture of the kinds of plants which dominated the vegetation at different periods in the past. He has skilfully steered a compromise course between the Scylla of technical jargon and the Charybdis of terminological inexactitude, and the book is written in a very readable and racy style.

The author is evidently an enthusiastic collector of fossil plants and will certainly stimulate others to take an interest in them. The study of fossil plants, palæobotany, has been greatly neglected in most countries, and in very few schools of geology is any instruction in palæobotany given. Such a book as this will help to show the geologist in how many different directions the study of plant fossils leads to a widening of our knowledge of the past history and climate of the earth.

The book is admirably printed and illustrated. One very impressive illustration is of an open-cast working at Wyodak, in Wyoming, in which there is a 90-ft. seam of coal. Other illustrations include excellent views of the Yorkshire coast and other places in Britain and North America which are notable for the fossil plants which have been found there. The author gives a clear idea of the appearance and nature of fossil plants and where they may be discovered. He explains the manner in which coal has formed and some of the methods used in investigating its structure. For those who have had no botanical education he provides a useful little appendix on the structure of living plants.

The author in the next edition should provide fuller descriptions of the illustrations and make greater use of letters with guide lines. In some illustrations (for example, Fig. 100) there is nothing to indicate the positions of the parts mentioned in the description, and the non-specialist reader will be at a loss to understand what the figure represents.

JOHN WALTON

APPEAL OF MUSEUMS

Native Animals of New Zealand

(Auckland Museum Handbook of Zoology.) By A. W. B. Powell. Pp. 96. (Auckland: Auckland Institute and Museum, 1947.) N.p.

THE educational function of museums has been much discussed in Great Britain during the last decade but, with notable exceptions, the attractiveness of their exhibitions has not been great enough to draw in and hold many, apart from those who already have some interest in the museum contents. There are many reasons for this lack of appeal, one of them being lack of imagination on the part of museum authorities and a strange unfamiliarity with the methods by which the general public should be encouraged to compel its interest. For these and other reasons this book should be carefully studied by museum authorities; similar publications would do much to increase the attractiveness of their own institutions.

While the work primarily is meant to be a guide book to the New Zealand natural history exhibits in the Auckland Museum, the author has avoided the easy temptation of allowing it to become a mere catalogue. The book is, in fact, a popular treatise on the native fauna, providing simple descriptions, recognizable illustrations and brief but essential information concerning the better known and more interesting New Zealand animals. For ease of recognition the figures have been drawn from actual specimens and, in order to help the amateur naturalist in recognizing animals in their natural surroundings, the text is mainly concerned with external appearances, habitat and behaviour. In keeping with evolutionary theory the animals have been arranged approximately in their systematic order although, since the handbook is mainly concerned with sight identification, all microscopic animals are omitted.

A cursory glance at the 411 illustrations shows some of the peculiarities of the New Zealand fauna. The absence of land mammals is at once conspicuous, and the inquisitive reader finds a reason for this expressed in clear and interesting language. The comparatively large number of flightless birds is also readily apparent and is accompanied by a careful account of each species. Animals like the tuatara (*Sphenodon punctatus*) and *Peripatus* are given special mention, as are the remarkable summer migrations of birds like the godwit and cuckoos. Mr. Powell must be thanked for producing a work which will not only add to the attractiveness of his own museum but which should also put ideas into the heads of discriminating museum workers elsewhere.

T. H. HAWKINS

V. Rosický

By F. Slavík. Pp. 24. (Prague: Czech Academy of Science and Arts, 1946.) 12 crowns.

PROF. VOJTĚCH ROSICKÝ was a distinguished Czech mineralogist whose scientific work was cut short by his execution at Mauthausen concentration camp in February 1942, in his sixty-second year. His father, who died in 1919, had been a naturalist and writer on scientific subjects, and young Rosický grew up in an atmosphere of excursions to forest and mountains in search of specimens. He began as science master at a Prague *Gymnasium*, for which he wrote a "Chemie a Mineralogie". Later he went to Munich as Groth's assistant; eventually he returned to Prague and, in 1920, became professor of mineralogy at the new University of Brno. His publications—mostly in Czech although some appeared in the *Zeitschrift für Krystallographie* and in French journals—dealt with crystallographic methods, the physical properties and measurements of crystals and the relation between physical properties and water content. He described, often in great detail, a variety of minerals from Europe, South Africa and South America, including a joint work with V. M. Goldschmidt on a topaz from Minas Geraes. Rosický also made some petrographical studies and wrote several text-books, including a lengthy "Krystalografie", one volume of which appeared in 1929 (with more than five hundred illustrations). The second half he left in manuscript, which is now being prepared for publication by Dr. J. Sekanin, with whom he was conducting X-ray crystallographic researches until the University was closed in 1939.

Prof. Slavík, himself a mineralogist well known in Britain, has written this short biography in appreciation of his countryman's contributions to mineralogy.

J. G. F. D.

L'Organisme en lutte contre les microbes

Par André Boivin et Albert Delaunay. (L'Avenir de la science, 24). Pp. 425 + 15 plates. (Paris: Libr. Gallimard, 1947.) 320 francs.

THIS latest addition to Gallimard's popular science series is of the same high standard as its predecessors, some of which have already been reviewed in *Nature*. Without diminution of scientific value the subject has been reduced to terms which can be understood by non-medical readers, but the book would be useful and easy reading for medical students preparing for examination.

The first part describes bacteria and viruses and the nature and evolution of infectious diseases. The second part describes the body's defences against invading organisms; the role of the phagocytes, antigens and antibodies. Part three deals with prevention and treatment of infectious diseases. Recent advances in chemotherapy and antibiotics are included. There is a detailed list of contents, but, unfortunately, no proper index.

The Annual Register

A Review of Public Events at Home and Abroad for the Year 1946. Edited by H. T. Montague Bell. Pp. xii + 504. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1947.) 42*s*. net.

THIS valuable volume makes its one hundred and eighty-eighth appearance as a full and objective record of the year's events. It is under new editorship, Dr. Epstein having died during the past year, but retains its well-established plan and scope. British history is told in four sections, followed by the history of the Commonwealth and Empire, with the troubled story of India and Burma. Then an equal share is devoted to foreign history, including the United Nations Organisation. Here the four Great Powers have the major part, but naturally the States of the troubled eastern side of Europe receive considerable attention. The latter part of the book is devoted to the usual chronicle of the year, obituaries and surveys of literature, art, science and finance. The public documents printed in full are the Anglo-Siamese agreement, the Yalta agreement and the White Paper on India.

Outlines of the Geography, Life and Customs of Newfoundland-Labrador (the Eastern Part of the Labrador Peninsula)

Based upon Observations made during the Finland–Labrador Expedition in 1937, and the Tanner Labrador Expedition in 1939, and upon Information available in the Literature and Cartography. By Prof. V. Tanner. Vol. 1. Pp. ii + 436. Vol. 2. Pp. ii + 437–909. (Cambridge: At the University Press, 1947.) 2 vols., 50*s*. net.

LABRADOR has a considerable literature of its own, as the full bibliography in this volume shows, but it is mainly concerned with the coastal regions which constituted that part of Labrador under the rule of Newfoundland. In 1927 the Privy Council brought within Newfoundland–Labrador the Atlantic drainage, leaving the remainder to Canada. Thus an area of about 100,000 square miles is a dependency of the former dominion of Newfoundland. The two large and beautifully illustrated volumes of this work, originally printed in Finland in *Acta Geographica*, do not claim to present a completely co-ordinated geography of Labrador. They contain rather the raw materials of such a work, from which much can be deduced. But the work is admittedly incomplete, partly because of the vastness of the area and partly because the second expedition of Prof. Tanner in 1939 was interrupted by the outbreak of war. It is, however, of interest to note that Prof. Tanner, versed in the conditions of Finland, sees no reason why much of Labrador should not eventually be colonized, even if it cannot become a self-supporting agricultural country.

I Know an Island

By R. M. Lockley. (Harrap's Country-Lovers Library.) Pp. 243. (London: George G. Harrap and Co., Ltd., 1947.) 8*s*. 6*d*. net.

ISLANDS where the sea-birds come to breed have a peculiar fascination, an appeal felt early and with great force by Mr. R. M. Lockley. He was not happy until he had acquired one, and even then he was not satisfied. Skokholm, that sanctuary of Manx shearwaters, storm petrels, puffins, etc., off the Pembrokeshire coast of Wales, only whetted his appetite for islands. In his book "I Know an Island", first published in 1938 and now reprinted, he tells of his own island of Skokholm, the neighbouring islands of Skomer, Grassholm and Ramsey and their inhabitants, both winged and furred, before going on to islands farther afield. The Blaskets off the Irish coast, Heligoland, Fair Isle, the Faeroes and the Westermann Islands are among those visited and interestingly described, with special reference to ornithological matters. For example, Mr. Lockley searched far for Leach's fork-tailed petrel, to find it at last on Sudurey in the Westmann Islands. F. Prrr

LOW-TEMPERATURE PHYSICS IN NORTH AMERICA

By Prof. J. F. ALLEN
University of St. Andrews

DURING the past summer, an opportunity was taken to visit the principal laboratories in the United States and Canada which are engaged in low-temperature research, with the exception of the Naval Research Laboratory in Washington, the laboratory directed by Giauque at Berkeley and that planned by Long at Chicago.

Prior to the War, comparatively little interest was shown in America in cryogenic research, with the notable exceptions of the Chemical Laboratory at Berkeley and the McLennan Laboratory at Toronto, and on the whole what interest there was lay in the field of chemical thermodynamics. To-day, although the position is changing rapidly, and again with the possible exception of Berkeley, there are still no cryogenic laboratories in America such as we know them on the eastern side of the Atlantic, equipped to carry out physical research in all the principal low-temperature fields, of which the three most important are superconductivity, paramagnetics and the properties of liquid helium. But the position is changing very rapidly indeed. There is in America a growing realization of the importance of low-temperature physics, and a very rapid growth in the number of laboratories using liquid helium. There are roughly a dozen such at the present time, and another dozen will probably be added within the next year.

This extremely rapid growth has been made possible largely by the new liquefier designed by Collins of the Massachusetts Institute of Technology. This liquefier can be considered as deriving from the one designed by Kapitza, but it is carried a stage further in that all the cooling is obtained by the principle of external work, and no other refrigerant, such as liquid air or hydrogen, is required. There are in the Collins machine two expansion cylinders and pistons, one operating at roughly the temperature of liquid air and the other at the temperature of liquid hydrogen. There is essentially only one heat exchanger, which is tapped off at two points to feed the cylinders, and at the bottom end is the Joule–Thomson valve where liquefaction is performed. The whole apparatus is extremely simple and elegant. It has been designed for something like mass production and can now be purchased, more or less 'over the counter', from the Arthur D. Little Corporation of Cambridge, Mass., for 18,000 dollars (August 1947 price). For this, it was learned, one obtains the complete plant, including gas holder, garage-type compressor, helium purifier and auxiliary vacuum pump, installed and ready to run. The whole assembly, less the gas holder and compressor, is fitted into a rectangular box about 5 ft. 6 in. in height, 3 ft. 6 in. wide and 3 ft. deep. The machine takes about four hours to cool to helium temperature and will then produce somewhat less than two litres of liquid helium an hour. It is not limited to helium production, but by its nature it will liquefy any gas. If, however, other liquid gases are wanted, it is possible to use helium as the working substance and liquefy other gases by contact, and it can thus provide a particularly useful and safe way of making liquid hydrogen.

The Collins liquefier, being compact, self-contained and simple to operate, is an admirable liquefier for the laboratory in which it is desired simply to extend existing researches or measurements to the helium range of temperatures. Also, it is designed expressly for the purpose of having experimental apparatus installed directly in the liquefier, since there is an opening in the top some 5 in. in diameter and a clear space beneath at least as large leading directly to the liquid helium bath. These reasons, together with the fact that the U.S. Navy makes extremely generous provisions for physical research in America, produce a tendency in the more ambitious laboratories to have a separate Collins machine for each experiment. Both the Naval Research Laboratory in Washington and the Massachusetts Institute of Technology have two liquefiers, and it was understood that both laboratories were planning to acquire additional ones.

It is, of course, easily possible to decant the liquid helium from the Collins machine; but that requires additional equipment such as Dewar vessels and liquid air for the thermal shielding, which are not always available. Hence the liquefier tends to be used for experiments which do not require either visual observation through the apparatus or the presence of magnetic fields. Furthermore, due to the comparatively poor shielding of the liquid in the liquefier from room-temperature radiation, it is not easy to reach a very low temperature by reducing the vapour pressure of the liquid.

Two other helium liquefiers which are being constructed are of interest. In Toronto an attempt is being made to use a turbine as a means of extracting work, and in the Ohio State University at Columbus a very large output of liquid helium is expected from a Joule–Thomson liquefier using only liquid hydrogen, of which there is a plentiful supply, as a refrigerant. A feature of the laboratory at Columbus was the immense size of the cryostats. The glass Dewar flasks, made on the premises, were four to five feet in height and six to eight inches in diameter.

Several other laboratories have small Linde or Simon single-expansion liquefiers, and at Yale there is a more or less exact replica of the Kapitza liquefier in the Royal Society Mond Laboratory at Cambridge.

Of the low-temperature research which is going on there is, of course, a considerable amount of accurate calorimetry devoted to chemical thermodynamics. On the physical side, the most important subjects at the moment are the separation and properties of the isotope helium 3, and the behaviour of superconductors under the action of very high-frequency currents, using radar techniques.

The phenomenon of the disturbance of superconductivity by high-frequency fields was first observed by H. London in Bristol before the War, and the effect of using 25-cm. waves in superconductors and in normal metals has been examined in detail by Pippard in Cambridge since the War. At the Massachusetts Institute of Technology, under Slater, and at the Naval Research Laboratory in Washington, the problem is under investigation using 1·25-cm. waves. The superconductors which have been investigated so far are tin and lead, and the methods which are employed are slightly different in the two laboratories. At the Massachusetts Institute of Technology, the waves, conducted in by wave-guide, are reflected at the end of the guide by a superconducting element which is in the form of a cavity of the dimensions of the guide, across which a thin perforated superconducting membrane is stretched. At the Naval Research Laboratory the

waves are conducted down to a superconducting drum-shaped cavity and the energy absorption is measured by the determination of the ringing time of the cavity.

Slater has obtained results similar to those of Pippard, but the destruction of superconductivity was more complete, as was to be expected from the higher frequency which has been used. He is also studying the so-called anomalous skin resistance of normal metals at low temperatures.

The work on the properties of the rare isotope helium 3, which has a normal concentration of about one part in 10^4 of helium 4, has been done by Daunt at Columbus and Lane at Yale with the mass-spectrographic collaboration of Nier at Minnesota. Lane has found that the vapour above the surface of liquid helium has a higher concentration of helium 3 than has the liquid, which indicates that if pure helium 3 can exist as a liquid, then its normal boiling point will be lower than that of helium 4. Daunt has further shown that helium 3 does not participate in the surface transfer of liquid helium II, which means that helium 3 is not in the superfluid state, at least at temperatures above 1·5° K., whereas helium II loses its superfluidity at 2·19° K. The fact that helium 3 is not superfluid offers the possibility of considerable enrichment of the helium 3 content by 'straining' helium II through a porous plug—called by the Americans a 'superleak'. It was rumoured in America that there exists a small quantity, of the order of 1 c.c., of pure helium 3, but not produced by the above means.

Other research on helium II at Yale consisted in investigations on second sound, in which, among other things, an attempt was being made to convert ordinary sound into second sound by passage of the waves through a porous membrane. At the Massachusetts Institute of Technology, Squire has made an investigation of the attenuation of ordinary sound, of ultra-sonic frequency, in liquid helium. Here the most important feature is the fact that the absorption rises to an indefinitely high maximum at the λ-point.

Among other researches in progress, Andrews at Johns Hopkins is investigating the phenomenon which he has discovered of the 'rectifying' property of the transition region in superconducting niobium carbide, which occurs in the neighbourhood of 15° K. One of the odd features of this phenomenon is that at a suitable temperature and with a suitable biasing current through it, the carbide specimen can pick up the local radio station with the aid of an amplifier and loud-speaker.

Boorse, at Columbia, is also planning to investigate niobium carbide and nitride, but from the magnetic point of view. He has a Simon expansion liquefier. Brickwedde, of the U.S. Bureau of Standards, also has a Simon liquefier of about one quartre-litre capacity. Aside from his calorimetric work, he is investigating the so-called 'overshoot' phenomenon in superconductivity which he discovered some years before the War. Some criticism has been expressed of the reality of this phenomenon, which involves very high measuring currents, owing to the possibility of local temperature fluctuations, and he is planning to repeat the investigations on indium, which has a transition temperature in the helium II region, where temperature fluctuations are much more difficult to produce.

None of the cryogenic laboratories visited are at present engaged on magnetic cooling experiments, although one or two of them intend to commence such work within the next year or two.

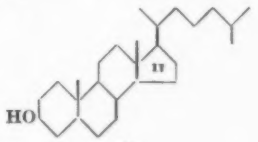
TOWARDS THE SYNTHESIS OF CHOLESTEROL

By Dr. J. W. CORNFORTH and Sir ROBERT ROBINSON, F.R.S.

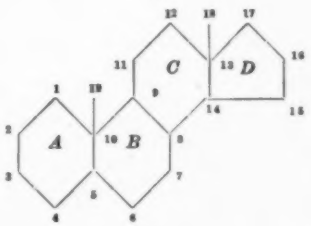
National Institute for Medical Research and Dyson Perrins Laboratory, University of Oxford

NO development of organic chemistry or of biochemistry has unfolded in a more dramatic manner in recent years than that concerned with the nature and functions of the steroids, the bile acids, and the related vitamins and hormones.

The typical compounds, cholesterol and cholic acid, excited the curiosity of Windaus and of Wieland because of their complex and obviously interesting molecular constitution; and the brilliant researches of these pioneers were supplemented by contributions from many other laboratories, especially when discovery of the biological significance of the group came to light. The chemical puzzle was transformed into a problem of vital urgency for physiology and medicine. The outcome has been that the structures of the chief members of the rapidly expanding family of substances are known in so far as that is possible without the final confirmation of successful synthesis. This latter task has been regarded as one of the most difficult that could be undertaken by the organic chemist, for the simple reason that it is far from sufficient to devise a method of constructing a substance corresponding to the formula as written on paper, difficult though that may be in itself. The molecule of dihydrocholesterol (I) contains nine asymmetric carbon atoms, and hence 512 stereoisomeric forms are possible. There is reason to believe that all these should be capable of existence. Even if the side-chain is not present, and position-17 carries a carbonyl group, there are still 128 stereoisomeric modifications. It is a triumph of analysis that a combination of chemical and physical methods, culminating in the X-ray crystallographic studies of cholesteryl iodide[1], has disclosed the stereochemical configuration of the ring-systems (cf. II) in the best-known steroids.



(I)



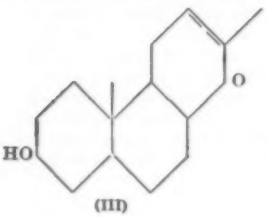
(II)

Rings *A* and *B* are fused together in the *cis*-position (coprosterol, cholic acid) or *trans*-position (dihydrocholesterol) in various derivatives, whereas rings *B* and *C* are fused in the *trans*-position in all known cases. For any given orientation of rings *A* and *B*,

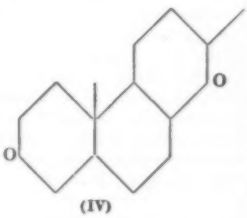
there are two such *trans*-fusions of *B* and *C*. Expressed in a different way, the configuration of C-9 must be established correctly in relation to C-10; that of C-8 must then be correct in relation to C-9. It is not necessary at this stage to discuss the fusion of rings *C* and *D*.

After a long series of investigations in other directions, we selected a synthetic route which had the useful feature that the stereochemical vagaries were placed under the maximum of control. The ring *A* was added to *B* : *C* in such a way that modification of ring *A* was feasible, while C-9 and C-8 (of II) were not yet asymmetric centres. It was shown at this stage that *cis*-fusion of *A* and *B* had been effected. The asymmetric centres at C-9 and C-8 were then set up, from analogies in *trans*-relation, and a separation of two series achieved in which the relation C-9 : C-10 was in the two possible senses. In this way a tricyclic substance was obtained which was convertible into a derivative of a tricyclic degradation product of desoxycholic acid. We have also completed the transformation of a cholesterol degradation product into the same substance. Thus sixteen carbon atoms have been joined in the space arrangement obtaining in coprostanone (for exactness), and the first synthetical proof of the existence of an angle-methyl (C-19) attached to C-10 has been given.

The Tricyclic Degradation Products. The oxidation of methyl O-diacetyldesoxycholate by means of chromic acid[2] afforded a number of neutral products in small yield. After hydrolysis, Reich[3] showed that one of these is an unsaturated keto-alcohol the constitution (III) of which follows from that of desoxycholic acid. By reduction, followed by oxidation, III gave a saturated diketone (IV).

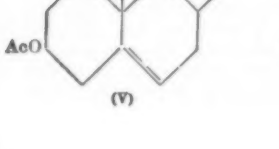


(III)

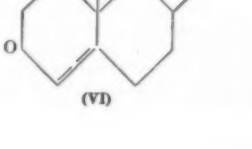


(IV)

Köster and Logemann[4] obtained (V) by suitable treatment of the mother liquors from the oxidation of cholesteryl acetate dibromide, after separation of acetates of dehydroandrosterone and pregnenolone. A small quantity of (V) was kindly supplied by Dr. K. Miescher of the Research Laboratory, Pharmaceutical Department, Ciba Company, Basle. By successive hydrolysis, oxidation (to VI), and reduction (a new stage), it was converted into (IV) (Specimen *A*). Specimen *B* is the Reich diketone (IV), for which we are indebted to Dr. H. Reich and Prof. T. Reichstein. Specimen *C* is the synthetic diketone (IV). We are very grateful to our Swiss colleagues for their generous help.



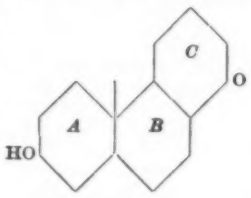
(V)



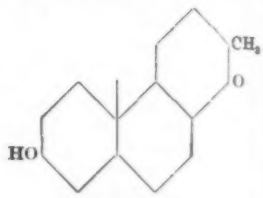
(VI)

The melting points, mixed melting points, and rotatory powers of *A*, *B*, and *C*, showed them to be identical. Dr. D. Crowfoot was able to use single-crystal technique for the examination by X-ray methods and has reported the complete identity of the three specimens. We are greatly obliged to her for such a satisfactory investigation made on the eve of a journey to the United States.

The Method of Synthesis. The preparation of (VII) from 1 : 6-dihydroxynaphthalene has already been described[5]. Considerable modifications and improvements have since been made in the details of the necessary operations, and transformations of the intermediate products have been realized such as to prove that rings *A* and *B* in (VII) are in *cis*-relation.



VII) (*A* and *B*)



(VIII) (*A* and *B*)

Although early specimens of (VII) were homogeneous (*A*-isomeride), it became evident, when larger quantities were available, that two isomerides were produced. These were first recognized after the preparation of the hydrogen succinates, which derivatives still afford the best method of separation. After hydrolysis, the hydroxy-ketones *A* and *B* are obtained in the ratio of about 6 :1. On oxidation they yield diketones *A* and *B*, so that their isomerism is not wholly (and probably even not partly) dependent on the configuration of the *sec*-alcoholic group. It must be connected with the mode of fusion of rings *B* and *C*. But (VII) is an α-decalone and has been subjected to treatment which is known to convert *cis*-α-decalone into the *trans*-isomeride. Hence the hydroxy-ketones (VII), *A* and *B*, probably represent the two possible *trans*-fusions of rings *B* and *C*. The optical resolution of the hydroxy-ketones *A* and *B* was then studied.

In the *A*-series, the crystallization of the *l*-menthoxyacetates was applicable and both enantiomorphs were obtained in a pure condition; m.p. 120·5–121·5°; $[\alpha]_D^{20} \pm 38{\cdot}5°$ (± 2°) in chloroform. In the *B*-series crystallization of the brucine salt of the hydrogen succinate afforded the pure derivative of the *B* (−) hydroxy-ketone. The *B* (+) hydroxy-ketone (VII) could be purified as the hydrogen succinate and was also obtained in a pure condition; hemihydrates, m.p. 113–114°; $[\alpha]_D^{20} \pm 10°$ (± 0·5) in chloroform. Only 1·132 gm. of the *B*-isomeride hydrogen succinate was available for this resolution.

For the introduction of a methyl group in the 2-position (phenanthrene numbering), the method of Sen and Mondal[6] was employed; namely, successive formylation, methylation and hydrolysis. The hydroxymethylketones (VIII) were then oxidized to give two pairs of methyl-diketones of the structure (IV).

The methyl-diketones-*A* had m.p. 141–142°, $[\alpha]_D^{20} \pm 20°$ (± 2°) in chloroform. The methyl-diketones-*B* had m.p. 116·5–117·5°, $[\alpha]_D^{20} \pm 25°$ (± 2°). Reich[3] attributes m.p. 119·5–121° to his specimen *B*, but this melting point was taken on

the Kofler-block and corrected (± 2°). Under our conditions the specimen provided had m.p. 116·5–117·5°. The same was true of specimen-*A*, made from the Köster–Logemann keto-acetate. Mixtures of the specimens had the same melting point. A full account of the experiments briefly summarized herein will be published in another place.

Prognosis. The synthesis of the tricyclic degradation product undoubtedly opens the way to a total synthesis of cholesterol and its ramifying derivatives. Referring to (II), the configuration of positions 5, 10, and 9 is secure, and that at 8 is also unlikely to be affected by subsequent changes at 14 and 13. We now propose to add ring *D* in a simple manner and hope to obtain two isomerides dependent on the relation of configuration C-13 to C-9. If that is found possible, the total synthesis becomes a matter of routine and eventually will certainly be accomplished.

[1] Carlisle and Crowfoot, *Proc. Roy. Soc.*, A, **184**, 64 (1945).
[2] Reich and Reichstein, *Helv. Chim. Acta*, **26**, 2102 (1943); **28**, 863 (1945).
[3] Reich, *Helv. Chim. Acta*, **28**, 892 (1945).
[4] Köster and Logemann, *Ber. Deut. Chem. Ges.*, **73**, 299 (1940).
[5] Cornforth and Robinson, *J. Chem. Soc.*, 676 (1946).
[6] Sen and Mondal, *J. Ind. Chem. Soc.*, **5**, 609 (1928).

PESTS OF STORED FOODS

FOOD AND AGRICULTURE ORGANISATION CONFERENCE

A MEETING of scientific workers concerned with pests of stored food was held in London in the week of August 4. The meeting was opened by Sir John Boyd Orr, director-general of the Food and Agriculture Organisation, who urged the delegates to propose methods which would enable Governments to preserve the 1947 harvest.

The subjects discussed included the appraisal of food losses; the spread of pests throughout the world; specific methods of control of insects and mites, of rodents and of fungi; storage methods; the world supply position of poisons; the dissemination of knowledge; and research needs. The chair was taken throughout by W. McAuley Gracie (United Kingdom), who contributed the opening paper on the economic significance of infestation. Most of the scientific papers were on the control of insects and mites. R. T. Cotton (United States) and H. E. Gray (Canada) presented comprehensive studies on the preservation of cereals from insect attack during storage. J. A. Freeman (United Kingdom) gave an account of world foci of infestation and channels of its dissemination, with suggestions for detection and standards of inspection. Prof. R. Mayné (Belgium) spoke on conditions and control methods in his country; R. Attia (Egypt) on conditions in both modern and ancient Egypt; K. R. Sontakay and H. S. Pruthi (India) on traditional Indian methods of storage and on modern rat-proof construction; Prof. P. Vayssière (France) on the principle of air-tight ensilage. A detailed account of the methods of grain drying was given by T. A. Oxley (United Kingdom).

On rodents, E. R. Kalmbach (United States) sent a paper on rodent control in the United States, and S. A. Barnett (United Kingdom) gave an account of the principles of rodent control based on the work carried out in Britain during the War.

The secretary of the Conference, S. S. Easter (Food and Agriculture Organisation), gave a report on estimates of losses due to infestation of stored foods. It was agreed that it is quite impracticable to give any reliable estimate of losses for any large area. Various estimates were quoted, including the statement that 10 per cent of the world's stored food is destroyed by pests. It was, however, considered that all such estimates are likely to be below the mark, owing to the high proportion of food stored in small lots by peasant farmers and not entering world trade.

The methods of insect control include fumigation, spraying and dusting, as well as preventive measures such as grain-drying and improvement of hygiene and of building construction. The committee on grain-drying urged that a world-wide study of this problem should be made, so that improved methods could be devised for each area. Economic as well as technical problems are involved, since drying grain reduces its weight; and if the grain is sold by weight, this may entail loss to the producer.

For rodents, the sub-committee urged the general adoption of the method of poisoning, preceded by prebaiting with plain bait. This method, based on research at Oxford during the War, can ensure almost complete clearance in most areas if it is rigorously applied. Again, the preventive measures of improvement of hygiene and buildings were recommended; but it was pointed out that in many areas they can be part only of a long-term project.

Inevitably, the meeting became involved in the discussion of wider problems. There was complete agreement that every country needs a pest control organisation with a staff of trained persons, including scientific investigators and operators. International agreement on certain aspects of pest control organisations is also required. This is exemplified by occurrence of the transfer of pests from one country to another by ship. The transport of rats is an old story, and the damage has already been done. But the transport of some serious insect pests is a recent affair and is still going on. For example, the mill moth (*Ephestia kühniella*) was first noticed as a pest of mills in Germany in 1877; by about 1900 it had a world-wide distribution, and it now costs the British milling industry alone some thousands of pounds a year for cleaning and fumigation, apart from the losses due to infestation of flour and offals. Similarly, the spider beetle (*Ptinus tectus*) was unknown in England before 1892. By 1916 it had spread all over the country and is now to be found in every warehouse in Britain. Its original home was probably Tasmania. Neither of these species is to-day often intercepted on imports; but, had an adequate quarantine service been in operation in the late nineteenth century, the entry of both might have been prevented. During the past few years the Government organisation has intercepted insects not hitherto recorded in the United Kingdom, and in some instances previously undescribed species. The delegates of other countries, and notably Belgium and France, recorded experiences similar to those in the United Kingdom.

Within each country the need for a pest control organisation raises a number of problems which have a more general application than to pest control alone. Prof. J. W. Munro (United Kingdom) gave a paper on the dissemination of information. He dealt first with the need for improvement in the information services available to scientific workers, and in particular, of abstracting services. This, as always, commanded general support. He then went on to

refer to the problem of keeping administrators adequately informed. The extent to which administrators seek, or are given, advice varies greatly in different countries, and at different times in the same country. In times of crisis advice is readily sought, often when it is too late; at other times it may not be sought at all, and if offered, it may be disregarded. The meeting, said Prof. Munro, gave an opportunity of ensuring that scientific opinion was heard in high quarters, and he hoped that the meeting would state the strongest case it could to that end.

Finally, Prof. Munro and many others referred to the need for the education of transporters, warehousekeepers, millers, wharfingers and the general public. A few countries have done a good deal in this direction, and Denmark gave an example by showing an entertaining film illustrating how bad hygiene and ill-kept buildings encourage infestation. At the other extreme there are the backward countries, mainly in the tropics and sub-tropics. The delegate from Siam gave examples of the formidable problem of educating peasant farmers in pest control. It was, however, pointed out that there is much ignorance to be combated even in the more advanced countries, where it is still common to find farmers and traders who believe in spontaneous generation.

Delegates visited the Ministry of Agriculture and Fisheries Infestation Control Division building, the Pest Infestation Laboratory at Slough, a large-scale grain drying plant, an exhibition of food pests at the British Museum (Natural History) and a number of demonstrations on pest control methods.

The Proceedings of the meeting are to be published by the Food and Agriculture Organisation.

S. A. BARNETT
R. A. DAVIS

FUEL ECONOMY CONFERENCE OF THE WORLD POWER CONFERENCE

By DR. H. E. CROSSLEY

Fuel Research Station, Department of Scientific and Industrial Research

THE Fuel Economy Conference of the World Power Conference was opened at The Hague on September 2 by His Excellency Dr. G. W. M. Huysmans, Netherlands Minister of Economic Affairs, who was introduced by Mr. G. J. T. Bakker, chairman of the Conference. Dr. Huysmans welcomed the representatives of thirty-three countries, and told them that the critical world shortage of fuel gave additional importance to the deliberations of the Conference. It was hoped that the exchange of views on many aspects of fuel economy would be helpful to all the nations, and that the personal contacts made at the Conference would lead to collaboration in the future. The official delegates from Great Britain and France thanked the Dutch authorities for their hospitality, and looked forward to profitable discussions.

The opening speeches were followed by a lecture on "Atomic Energy for Peaceful Purposes", given by Prof. G. J. Sizoo. He pointed out that estimates of the economics of energy production by atomic fission, or of the size or nature of fission plants, are purely speculative, and often optimistic. In his opinion, atomic fission would probably become a supplementary source of energy, rather than a replacement of other sources. The alternatives of peaceful or aggressive use presented a challenge to mankind.

The first technical session of the Conference was a discussion of reports from nineteen countries on "Fuel Economy since 1939". These reports indicated the need for the direction of all fuels to the uses for which they are most suitable, to avoid many operational troubles and to provide higher efficiencies. The British report was appreciated for the account of ways by which the public have been informed of the more efficient use of fuels. A resolution was passed asking the International Executive Council of the World Power Conference, in consultation with the national committees, to consider the collection of target values for energy consumption per unit of product or effort, for discussion and publication. This resolution was later approved in principle by the International Executive Council.

Subsequent sessions were more specialized in character, as indicated by the following examples.

One session was concerned with liquid fuels, the subject of seven papers. The papers and the discussion showed the great interest in home production of liquid fuels from indigenous sources such as shale, oil sands, tar oil and wood. The commercial development of indigenous sources is, of course, dependent on the cost of imported fuels, and the quantities available for import. Dr. W. H. Zaaijer directed attention to the difficulty in several European countries of preparing motor spirit with a sufficiently high octane number, and suggested that production plants would have to be modernized to meet this demand.

In a session concerned with domestic appliances, the main subject of discussion was the desirability of having quality marks stamped on such appliances. These quality marks would be defined by standard specification of performance and design, and in consequence domestic appliances would be more efficient, and should be cheaper, due to the standardization of parts. It was felt that co-operation between appliance manufacturers and gas companies would be the best way of sponsoring advancements in the design of gas appliances. Co-operation is needed also between the gas and electricity industries, to avoid the production of undesirable appliances purely for competitive purposes.

The use of fuels for transport purposes was discussed in another session. Papers from Sweden and France showed the wastefulness of steam traction compared with electrical traction, the former requiring 2·5–3·25 times the amount of coal needed by the latter for the same load. In the United States Diesel traction is being favoured, particularly for branch line and shunting operations.

The session concerned with industrial and agricultural appliances received the largest number of contributions, twenty papers being submitted for discussion. These papers dealt with a variety of subjects, such as the use of low-grade fuels in various types of boilers and other furnace plant, the recovery of heat from waste liquors, the development of the gas turbine, and the significance of convection and radiation in heating by gas. It was stated that Britain alone had been frank in publishing operational troubles with power station boilers, and this frankness had been made possible by the collaboration of power station engineers and boiler manufacturers on the

British Boiler Availability Committee. Contacts with other countries were sought by this Committee, for the exchange of information and experience, and it was suggested that the structure of the Committee was worthy of emulation in many countries.

Four papers were submitted to the session concerned with the character of national fuel reserves, from Great Britain, Canada, the United States and France. The British contribution explained how the Coal Survey Section of the Fuel Research Organisation (Department of Scientific and Industrial Research) had helped in the production and preparation of coal, and in its storage, distribution and utilization.

Great interest was shown in the session concerned with atomic energy, although few members were able to offer contributions. It was thought possible that two kinds of fission furnace may be developed, one to use uranium 238, involving the preliminary conversion of this substance into fissile material such as plutonium, the other to use directly fissile material, such as plutonium, uranium 235 and 233. The second type of furnace would be much smaller than the first, but the material used by the first would be much more plentiful. Only 1/139 of the uranium in the earth's crust is directly fissile. If it became possible to use natural uranium, 170 tons per annum would satisfy the energy requirements of the world. Dr. W. Lulofs considered that as the world's supply of uranium would not be inexhaustible, it might be necessary to look for further sources of energy. For example, he wondered if it would be possible to build up helium from hydrogen, setting free a considerable amount of energy. Dr. J. D. Cockcroft replied that physicists had given such matters considerable thought, but with regard to the example cited, the necessary extremely high temperature is, as yet, prohibitive of progress. Several speakers considered that there had been over-optimistic views all over the world regarding the early development of atomic energy for industrial use. It is clear that many difficult problems have still to be solved before that hope can be realized; and at this stage the prospect is that atomic fission will have little, if any, financial advantage over present methods for the production of energy. It would, of course, set free very large amounts of fuels for other uses.

Other sessions considered developments in coal mining and coal preparation, economy measures in the production of gaseous fuels, the transport of gas, the transmission of electricity, and space heating. Several papers directed attention to the advantages arising from district heating in suitable towns.

The Netherlands National Committee, and an associated Committee of Ladies, arranged various technical and non-technical excursions. Facilities were provided for visits to the refineries and laboratories of the Bataafse Petroleum Maatschappij at Pernis, Delft and Amsterdam, the Philips works at Eindhoven, and the various works associated with the Netherlands State Coal Mines near Lutterade. Appreciation was expressed by all the members for the excellent organisation of the Conference and the arrangements made for the visits to works, laboratories, and places of general interest. The exchange of views and experience on the urgent question of fuel economy was felt to be most valuable and a real contribution towards the goal of economic recovery. The Conference had an even greater value in showing the benefits that can arise from a meeting of representatives of the countries of the world in a friendly spirit.

OBITUARY

Sir Albert Howard, C.I.E.

Botanists, agriculturists and many others will learn with regret that Sir Albert Howard died in London on October 20. He was born in 1873 and educated at the Royal College of Science and at St. John's College, Cambridge, where he was a foundation scholar. Here he worked under Marshall Ward, who was then attracting a brilliant group of students to some of the newer aspects of botanical science, and after taking first-class honours in the Natural Science Tripos in 1898, he proceeded in 1899 to the Imperial Agricultural Department for the West Indies, then newly established with the purpose of applying science to the difficult problems raised by the threatened collapse of the sugar-growing industry there. In 1903 he returned to England to succeed F. Escombe as head of the Botanical Department of the South Eastern Agricultural College, Wye, Kent. He was not, however, entirely happy at Wye, and left in 1905 to become Imperial Economic Botanist to the Government of India, where for the first time he found full scope.

In the same year Howard married Gabrielle Louise Caroline Matthaei, of Newnham College, who was already well known for her investigations on vegetable respiration and assimilation, and they worked together for nearly twenty years at Pusa in so close a collaboration that no one knew which part was hers and which was his. Their first work was on wheat, and they were fortunate in having available an important collection of varieties brought together by W. H. Moreland and grown continuously on the Cawnpore Experimental Farm by J. Haymon, the first deputy director of agriculture, and by Bryce Burt. At that time there was a considerable export of wheat from India to England, and the Howards sought varieties giving better yields than those commonly grown, and possessing more 'strength' as defined by the English millers. Fortunately, one or both of the Howards had the artist's eye for picking out the varieties likely to do well and those that would not, and their final selections and crosses proved remarkably successful, particularly Pusa 4 and Pusa 12 in the United Provinces and the North West Frontier Province. An account of this work was given in "Wheat in India, its Production, Varieties and Improvement" (1909), and a general summary of all their work up to 1929 in "Crop Production in India" (Oxford University Press).

While at Pusa the Howards in 1912 started a Fruit Experiment Station at Quetta, a district long known for fruit-growing; it was, however, abandoned in 1919. It was re-started in 1933, but no records of the older work could be found, nor were the surviving varieties suitable for the new conditions.

In 1924 the Howards left Pusa for the new Institute of Plant Industry, Indore, established to provide a farm for Bernard Coventry, agricultural adviser to the States in Central India. The general principle underlying their administration was that the crop was to be treated as a unit and studied in relation to the field and the village; there was to be no division of the scientific work into departments. A joint book, "The Application of Science to Crop Production", was published in 1929. Unfortunately, in 1930 Mrs. Howard died, and the long and fruitful partnership came to an end. Howard himself left India in 1931; he was knighted in 1934.

At Indore, Howard had worked with Y. D. Wad on composts. These have long been known in the East, and they have the double advantage of supplying much-needed organic matter to the soil, and of affording the means of keeping the villages cleaner than would otherwise happen. No new principle was involved in the work, but his enthusiastic, even passionate, advocacy served the valuable purpose of greatly extending the use of composts. Howard, however, went further and introduced ideas regarded by scientific workers as going beyond the experimental evidence. He embodied these in two books, "An Agricultural Testament" (1940) and "Farming and Gardening for Health or Disease" (1945), and they were ably and persuasively set out in "The Earth's Green Carpet" (1947) by his second wife, Louise E. Matthaei, an associate of Newnham College and formerly chief of the Agricultural Service of the International Labour Office, Geneva. Whatever the fate of these ideas, they have caused scientific workers in agriculture to re-examine the foundations on which their hypotheses are based—always a useful exercise.

Howard was active almost to the end. For a day or two he had been slightly unwell, then came a heart attack from which he did not recover. E. JOHN RUSSELL.

NEWS and VIEWS

Scientific and Technological Man-Power in Great Britain

THE report of the Committee on Scientific Man-Power (Cmd. 6824), it will be remembered (see *Nature*, June 15, p. 794, 1946), was based on the work of the Barlow Committee; both reports emphasized the vital need for increasing the output of trained men of science and technologists in Great Britain. In order that the part which universities and technical colleges will be called upon to play in this connexion may be estimated with greater accuracy than has been possible hitherto, the Advisory Council on Scientific Policy has asked for the help of the Technical and Scientific Register of the Ministry of Labour and National Service in measuring the existing man-power in the scientific and technological fields; to do this a comprehensive questionnaire is being sent out. The purpose of the survey is solely to obtain as complete an analysis as possible of the existing scientific and technological man-power in the United Kingdom and overseas in respect of its distribution in age groups between Government, industry, university and school teaching, and to use this analysis for estimating in which of the sciences it will be necessary to take special steps for increasing the output of the universities and technical colleges because of exceptionally heavy demands for home and overseas posts, previous and continuing shortages, or the high average age of any particular group. In asking for the completion of the questionnaire, the Ministry states categorically that the information provided will in no circumstances be used as a basis for any form of administrative control or direction. It is not being sought as a means of revising the Technical and Scientific Register of the Ministry of Labour.

A complementary inquiry is being conducted by the Ministry of Labour by specially appointed subcommittees of the Technical Personnel Committee presided over by Lord Hankey. These inquiries are designed to establish as nearly as possible the demands likely to be made by industry, teaching and Government service, both at home and overseas, in the various branches of science and technology during the next five to ten years, and committees have been set up to deal with chemical engineering, architecture and surveying, engineering, microbiology, entomology, geology and physics. The Committee on Chemical Engineering completed its work last year; draft reports have been prepared for architecture, surveying, microbiology and entomology; the engineering inquiry is well under way; and those into physics and geology have been commenced. It is hoped to set up a further committee in the immediate future to inquire into the future demand for chemists and metallurgists.

Committee on Science and its Social Relations

THE Committee on Science and its Social Relations, instituted by the International Council of Scientific Unions in April 1937, held its first post-war meeting in London during September 11–12. The members from the United States and from China were unable to attend, but Dr. V. Weiskopf from Cambridge, Mass., was present. A considerable part of the meeting was devoted to a discussion of the dangers facing the world from the possibilities of misusing science for war. The failure thus far to establish a world control of atomic (nuclear) energy is extremely embarrassing. Every effort towards a better understanding of the issues and dangers ahead must be supported by all means. Equally menacing dangers are connected with the possibilities of using bacteriological infections or poisons, control of which is far more difficult than that of atomic energy. It is important that those responsible for the strategy governing the armed forces of the United Nations should bear fully in mind the implications of these new weapons and of the speed with which they can be brought into operation. Equally, it is important to develop throughout the world a public opinion fully informed of the danger and strongly supporting measures leading to peace and international understanding. The whole future of the world depends on this. Much attention was also devoted to the position in which science has arrived through the legal secrecy restrictions now introduced in a number of countries; and through the support of scientific research by grants from military authorities and from industry.

The Committee decided to resume the work started before the War of making surveys of the social position of science in various countries. For this purpose the organisations adhering to the International Council (national academies and the like) will be asked to set up committees in each country to collect a number of specified data. Such a national committee, consisting of private individuals, already exists in Denmark and has done extremely valuable work there. Help will also be asked of the United Nations Educational, Scientific and Cultural

Organisation for countries not represented on the International Council; and contact will be made with the International Labour Office, the Food and Agriculture Organisation, the Economic and Social Council of the United Nations Organisation, and with the International Federation of Scientific Workers, in order to avoid duplication of work in so far as these bodies might have made inquiries of similar nature. The International Federation of Scientific Workers will also be approached concerning a charter of rights and obligations for scientific men.

Marconi Jubilee and Congress in Rome

As already recorded in *Nature* (May 3, 1947, p. 598), it is just fifty years ago that Marconi gave the first successful demonstration of wireless signalling in Great Britain. The fiftieth anniversary of the foundation of the Marconi Company was on July 20, and to mark the occasion a souvenir brochure was produced ("Jubilee Year, The Marconi Company." Pp. 58. Published by Marconi's Wireless Telegraph Co., Ltd., Chelmsford, 1947). This volume provides a brief and very interesting account of the development of wireless signalling by the Company, from the first practical transmissions over a few miles to the achievements attained in the fields of broadcasting, television and radar. The brochure is profusely illustrated by a large number of excellent photographs, many of which have a unique historical interest.

To mark the occasion of the Marconi Jubilee, the Italian National Council of Research held an International Congress in Rome during September 28–October 4. The Congress was attended by about two hundred delegates from some twelve countries: there were seven British delegates representing the Royal Society, Physical Society, Institution of Electrical Engineers, Government departments, both civil and military, and the radio industry. The technical part of the Congress comprised the presentation of a large number of scientific and technical papers describing progress in various fields of radio technique during the past twenty years or so. It is understood that these papers will be collected together and published in a special commemoration volume. Apart from one or two social events, the Congress visited the main transmitting station of the Italian Radio and Cable Co., some ten miles out of Rome. This station was extensively damaged during the War; but several long-distance short-wave circuits are now in operation. A special visit was also paid to Castel Gandolfo, at which the whole Congress was addressed by the Pope. The programme of celebrations provided the usual opportunities of meeting delegates from other countries and discussing matters of mutual interest in radio and allied fields.

Development of Insecticides and Weed-killers

Ten years ago, Plant Protection, Ltd., was formed to take over the agricultural and horticultural interests of Imperial Chemical Industries, Ltd., and Cooper, Macdougall and Robertson, Ltd., and a dinner was held recently in London to celebrate the achievements of the first decade. Replying to the toast of "Agriculture" proposed by Mr. S. W. Cheveley, managing director of the firm, Prof. Scott Watson outlined some of the remarkable advances made in recent years in the discovery and production of new insecticides and selective weed-killers. Plant Protection, Ltd., has been in the forefront of these advances. It has recruited research workers and formed an advisory service to study all aspects of the products that it markets, and give advice on how to use them. This service is international in scope. The Research Station at Fernhurst, which was taken over nearly two years ago, serves as a training centre for the technical staff as well as a research centre and demonstration centre. The Imperial Chemical Industries research stations of Hawthorndale and Jealott's Hill examine chemicals that may prove useful in plant culture, from the whole of the Imperial Chemical Industries organisation, and those that prove useful are passed on to Plant Protection, Ltd., for technical development, which is carried out at Yalding and Fernhurst. In addition, chemicals from sources outside Imperial Chemical Industries are examined and may be incorporated in the firm's range of products. Perhaps the firm's most notable contribution to the field of pest control is the production of 1,2,3,4,5,6-hexachlorocyclohexane in the 'Agrocide' range of products containing 'Gammexane'; but notable contributions have also been made to the study of plant hormones and the technique of application of seed dressings. The firm has also at its disposal the accumulated experience of Cooper, Macdougall and Robertson, Ltd., in the field of derris insecticides, a field in which they were pioneers. Plant protection is becoming, or has become, a matter for specialists, and Plant Protection, Ltd., has recognized this fact and is organising accordingly.

The Profession of Chemistry in India and Pakistan

Prof. Alexander Findlay, past president of the Royal Institute of Chemistry, accompanied by Mrs. Findlay, is to visit important centres of scientific activity in India and Pakistan. The main purpose of his mission is to study the steps that are being and might be taken in the two Dominions to ensure that due provision will be made, and on an increasing scale, for students to receive proper training in the science of chemistry and for a fuller recognition of the status of the profession. Prof. Findlay hopes to be present at the meeting of the Indian Science Congress and the annual meeting of the Indian Section of the Royal Institute of Chemistry at Patna in January 1948, as well as at the subsequent inauguration of the examinations for the associateship of the Institute at Bangalore.

Estimated Weight of the Largest Bird

In *The Condor* of July–August 1947 (**49**, No. 4), Dean Amadon gives an account of an investigation which he has made into the weight of the largest known bird. The ostrich (*Struthio camelus*), largest of living birds, was far surpassed in size by the elephant bird (*Aepyornis maximus*) of Madagascar; the larger of the New Zealand moas such as *Dinornis* were intermediate in size. The moas and elephant birds were exterminated by the natives of these islands and are known only from sub-fossil remains of skeletons, eggs and feathers. From available evidence, Amadon estimates that *Aepyornis maximus* weighed about 965 pounds and *Dinornis* about 520 pounds. This compares with a weight of about 250 pounds for the ostrich.

A Study of Cultural Phenomena

In an article entitled "The Expansion of the Scope of Science" (*J. Washington Acad. Sci.*, **37**, No. 6; June 15, 1947), Leslie A. White attempts to assess the ages and degrees of maturity of the sciences. The following 'law' is stated: "Scientific interpretation

will appear to grow fastest in those areas where the determinants of human behaviour are the weakest and least significant". These determinants are least effective where the identification of the self with the external world is weakest, that is, in relation to the heavenly bodies and other inanimate objects; hence the success of astronomy, physics and chemistry. The new interpretation has then spread to the biological sciences: anatomy, physiology, psychology and sociology, in that temporal order. Dr. White regards the latest science, culturology, as in a sense superior to all the others. Many sociologists and anthropologists, for example, Ralph Linton, Robert S. Lynd and Margaret Mead, agree that the study of culture is often neglected, and approve a present tendency to study personality in its cultural background or context. But Dr. White disapproves strongly of what he calls "the exponents of 'free will' in anthropology", yet when he writes "present day anthropology is both anti-evolutionist and anti-culturological" the reader may wonder what he means by free will, evolution and culturology.

Dr. White believes that culture traits react upon each other immediately and directly. He quotes the hoe as an example. It acts upon and influences other culture traits "such as division of labour between the sexes, customs of residence, food habits, religious beliefs and ceremonies and so on". But a hoe may act upon a clod, the hoer's foot or remain unused; and to-day fashions for or against certain tools or instruments are notoriously affected by propaganda and advertising. All these are examples of human interference. We are asked to treat cultural phenomena "as if they had a life of their own". But the instances the author quotes, where "the introduction of human organisms into a consideration of these problems is not only not necessary; it is irrelevant and confusing" can be claimed as examples of problems the solution of which is impossible if the effect of human beings is excluded. Even "studies of languages on a purely linguistic, i.e., non-biological level" are sadly incomplete if one ignores the living, speaking creature. Dr. White states his belief that culture has its own laws, but for this the present article offers little evidence.

Commonwealth Fund Fellowships

THE Commonwealth Fund of New York, a philanthropic foundation existing since 1918 and supported by endowment from the late Mrs. Stephen V. Harkness and the late Mr. Edward S. Harkness, has established for British subjects a number of fellowships tenable in the United States. Not more than twenty ordinary fellowships will be offered in 1948. Candidates must be of British descent, graduates of recognized universities of the British Commonwealth, and be between the ages of twenty-three and thirty-five on September 1, 1948. Not more than five service fellowships will be available for candidates of British descent who hold Government appointments overseas in the British Commonwealth. Not more than three Home Civil Service fellowships will be offered for candidates holding appointments in the Home Civil Service. None of these fellowships is open to women. There is no fixed stipend; but it is estimated at a minimum of approximately 3,500 dollars for twelve months, and is intended to cover the full expenses of residence, study and travel in the United States during the year. All applications must be submitted on the prescribed form, and must be approved by the authorities of the college or university of which the candidate is, or has been, a member. They must reach the Secretary to the Committee, Richard H. Simpson, Commonwealth Fund Fellowships, 35 Portman Square, London, W.1, by February 1, 1948.

Volcanic Activity in 1946

ACCORDING to *Earthquake Notes*, **18**, Nos. 1 and 2, September 1946, the first new volcanic activity of 1946 was on February 17 when a volcano on Niuafoou in the Tonga Islands erupted violently and the lava flow partly covered a village. In the same month, in Baluchistan, a volcano north of Karachi, India, began emitting mud, and 200 miles south of Yoksuka naval base, Japan, a volcanic island rose from the sea. On March 20 Mount Sakura-Jima in southern Japan blew boulders more than 1,000 ft. into the air and sent up a smoke column 3,000 ft. high. Lava flows doomed nearby villages. On May 11 Izalco volcano in El Salvador erupted after twelve years quiescence. Santiago volcano in Nicaragua began smoking in June. On September 25 Stromboli in Italy was again active. Continued activity was reported from Kluchenskayo volcano on the Kamchatka Peninsula, which erupted in December 1944, while in New Zealand, Mount Ruapeku continued to shower dust over a wide area after the outbreak in August 1945. Paricutin volcano was intermittently active during the year, but there was an overall subsidence. Volcanic ash, reported over the Aleutian Trench in 1945, was later found to be due to a spectacular eruption on Umnak Island, which blew steam and ash several thousand feet into the air.

Chemical Composition of the Stars

A RECENT paper by Mr. F. Hoyle introduces some revolutionary conceptions regarding the internal constitution of the stars (*Mon. Not. Roy. Ast. Soc.*, **106**, 4; 1947). Until comparatively recently it was usually assumed that the stars contain about 30 per cent of hydrogen and 10 per cent of the heavy elements; but an accumulation of observational evidence during the last fifteen years indicates that this proportion of the heavy elements is much too high. Hoyle shows that the data are more consistent with the view that, at the time of condensation of the stars, 99 per cent, and probably more than this, must have been in the form of hydrogen, the remainder consisting of heavy elements. The mean molecular weight of a star at the time of condensation must have been about 0·5, and a subsequent increase in this could arise only by the conversion of hydrogen into helium by thermonuclear reactions. In the case of small stars like the sun, very little change in composition has taken place during their life-times, so that the sun would now consist almost entirely of hydrogen. This constitution differs so widely from that of the earth, which contains very little hydrogen, that it is impossible to accept the view (now somewhat discredited) that the earth and other planets once formed part of the sun. The high ratio of hydrogen to metals in interstellar matter, obtained in 1939 by Dunham, is, Hoyle points out, a powerful argument in favour of his supernova theory of the origin of the solar system, which was developed in *Mon. Not. Roy. Astro. Soc.*, **105**, 175 (1945), and of which a short account appeared in *Nature*, **157**, 881 (1946).

The Night Sky in December

NEW moon occurs on Dec. 12d. 12h. 53m., U.T., and full moon on Dec. 27d. 20h. 27m. The following conjunctions with the moon take place: Dec. 3d.

14h., Saturn 4° S.; Dec. 4d. 04h., Mars 3° S.; Dec. 11d. 11h., Mercury 2° N.; Dec. 14d. 20h., Venus 3° N.; Dec. 30d. 21h., Saturn 4° S.; Dec. 31d. 23h., Mars 2° S. In addition to these conjunctions with the moon, Mercury is in conjunction with Jupiter on Dec. 15d. 02h., Mercury being 0·6° S. Mercury is a morning star throughout most of the month, rising at 6h. 04m., and 7h. 12m. at the beginning and middle of the month respectively; on Dec. 31 the planet rises 12m. after the sun. Venus, an evening star, is conspicuous in the western sky for some time after sunset as an object of stellar magnitude −3·4; about 0·9 of the illuminated portion of the apparent disk is visible during the month. Mars, in the constellation of Leo, can be seen throughout the greater portion of the night, rising at 22h. 23m., 21h. 52m., and 21h. 04m., at the beginning, middle and end of the month, respectively, and is easily recognized from its proximity to Regulus, from which it moves eastward during the month. Jupiter, in conjunction with the sun on Dec. 1, is unfavourably placed for observation until the end of the month, when it is a morning star rising about 1¾ hours before the sun. Saturn, in the constellation of Leo, is well placed for observation, rising at 21h. 46m., 20h. 50m., and 19h. 44m., at the beginning, middle and end of the month, respectively. Occultations of stars brighter than magnitude 6 are as follows: Dec. 2d. 04h. 53·2m., λ Canc. (*R*); Dec. 8d. 06h. 20·5m., *m*. Virg. (*R*); Dec. 25d. 23h. 40·2m., ϰ Taur. (*D*); Dec. 26d. 00h. 09·7m., υ Taur. (*D*). The times are given for Greenwich, and *D* and *R* refer to disappearance and reappearance, respectively. The Geminid meteors are active in the early part of the month; they have usually short paths and are not very bright. Winter solstice takes place on Dec. 22d. 17h.

Chemistry of Penicillin at the University of Oxford

Sir Robert Robinson writes: "In the very flattering notice published in *Nature* of November 22, p. 703, the statement is made that it was in my laboratory that the main facts of the constitution of penicillin were elucidated. This is incorrect, because many of the fundamental observations were made in the laboratory of the School of Pathology. I think a claim for 'Oxford' as a whole has been misunderstood as applying to the Dyson Perrins Laboratory. The collaboration between Drs. E. P. Abraham and E. Chain, Prof. W. Baker and myself was a close partnership, and contributions were made by both laboratories. In the summer of 1943, penicillamine was synthesized by Dr. and Mrs. J. W. Cornforth, working in the Dyson Perrins Laboratory, but independently, and in the early autumn and later, the attack developed in collaboration with other centres, especially the Imperial College of Science and Technology, in the remainder of 1943. The complex development cannot be easily summarized, but an attempt is made in Chapter 1 (*Science*, 105, No. 2739, 653; 1947) of the monograph in course of preparation."

Announcements

Dr. B. P. Dey, director of the Board of Industrial and Research Schemes in Presidency College, Madras, formerly professor of chemistry in that College, has been appointed director of the Indian institute of Science, Bangalore, in succession to Sir J. C. Ghosh, who is now director-general of industry and supply to the Government of India.

The following appointments in the University of Leeds have been announced: Dr. N. B. Slater, honorary curator of the Cecil Duncombe Observatory; Mr. J. Mars, lecturer in economics; Mr. D. Johnston, lecturer in metallurgy.

The following appointments in the University of Sheffield have been announced: H. Ferrari, lecturer in mining; Dr. W. Hume-Rothery, honorary lecturer in the Department of Metallurgy; Prof. H. N. Green, professor of pathology, granted the additional title of director of cancer research. The following resignations have been announced: G. E. Cooke, lecturer in civil engineering; Dr. H. McIlwain, lecturer in biochemistry.

The following Colonial Service appointments have been announced: J. S. Blacklock, to be agricultural officer, Sarawak; G. P. Blair, to be agricultural officer, Trinidad; M. H. Breese, to be entomologist, Nyasaland; A. J. P. Goodchild, to be entomologist, Gold Coast; J. L. Jollans, to be agricultural officer, Gold Coast; E. H. Nichols, to be agricultural officer, Sierra Leone/Gambia; W. A. Wright, to be agricultural officer, Sierra Leone/Gambia; G. E. Crichton, to be assistant conservator of forests, Sierra Leone/Gambia; Capt. P. B. Finn, to be staff surveyor, Kenya; J. B. Lyle, to be superintendent of surveys, Palestine; E. F. Martin (deputy director of agriculture, Uganda), to be deputy director of agriculture, Kenya; L. D. E. F. Vesey-Fitzgerald (entomologist, Nigeria), to be senior assistant game warden, Kenya.

A new abstract journal, described as "a monthly service of information about developments in technology and research for business men, investors, the Press, educationists and suppliers of services to industry", has appeared under the title *Facts for Industry* (A. E. Blake, Lower North Dean, Hughenden, High Wycombe, Bucks. Annual subscription, 2 guineas). Abstracts vary in length from about fifty to five hundred words, and are classified by subjects; references to original papers are quoted. The October issue consists of twelve pages including thirty-eight abstracts.

The Hungarian Academy of Sciences has started issuing the following new scientific periodicals, the papers in which are all published in English, French or German: *Hungarica Acta Mathematica*, *Hungarica Acta Physica*, *Hungarica Acta Chimica*, *Hungarica Acta Physiologica*, *Hungarica Acta Biologica*, *Hungarica Acta Medica*. Each volume consists of six fascicles of about 15–17 sheets, and the price has been fixed at 35*s*. (7 dollars, or 30 Swiss francs) per volume. The Academy would welcome the exchange of publications with other scientific institutions, in connexion with which communications should be sent to the office of the Academy, Budapest V, Akadémia-utca 2.

The Prix Arnold Reymond, provided by the Fondation Charles-Eugène Guye, is offered by the University of Lausanne for a memoir on the tendencies of scientific philosophy during the preceding ten years. The award is made at intervals of between five and ten years, the first award having been made in 1944 to Dr. Pierre Lecomte du Noüy. Memoirs to be considered for the next award, which will amount to at least 1,000 Swiss francs, must reach the Commission du Prix Arnold Reymond, Fondation Charles-Eugène Guye, Secrétariat de l'Université, Lausanne, by January 1, 1951.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Blackett's Fundamental Theory of the Earth's Magnetic Field

Soon after the publication of Prof. P. M. S. Blackett's paper[1], Dr. E. C. Bullard suggested to us that it should be possible to test Blackett's theory against other theories by measurements of the magnetic field of the earth in the mines of the Witwatersrand. By courtesy of the management of the Blyvooruitzicht G.M. Co., we made a series of underground observations on Blyvooruitzicht mine.

Using an Askania horizontal magnetometer (Schmidt type), we measured ΔH at five points underground on three successive days, giving in all fifteen determinations of ΔH. A similar instrument was read at the surface at 5-min. intervals during the duration of the underground measurements, so that we were able to allow for diurnal variation. The observations were not as satisfactory as we had hoped, in that there was a larger closing difference than we had expected when the underground instrument was brought back to the surface base station after the observations underground. This difference amounted to 14, 22 and 32 gamma on the three separate days.

The observations were referred to the mean of the values found at four points on an east–west line of 300 yd. centred above the points at which the underground observations were made. The closing error was allowed for in two ways: (1) it was assumed that it was due to random errors of reading, and ΔH was calculated from the mean of the initial and final surface readings; (2) it was assumed that the closing difference was due to a drift linear in time.

The final results for the full fifteen sets of observations with their standard deviations are:

H (underground) $-$ H (surface) $= -26 \pm 4\,\gamma$, corrected according to (1), and
H (underground) $-$ H (surface) $= -24 \pm 4\,\gamma$, corrected according to (2).

For the three days separately, these results were:

-31 ± 9, -21 ± 4 and -25 ± 2, corrected according to (1); and
-30 ± 10, -19 ± 4 and -23 ± 1, corrected according to (2).

The mean depth of the observation points below the mean surface for a distance of five miles from the observation point was 4,800 ft.

In a private communication (to be published), S. K. Runcorn compares the variation of the field with depth for Blackett's theory and for all theories which attribute the magnetism to processes in the central core of the earth. He obtains the formula:

Blackett's theory: $H_d = H_0 \left\{1 - 2\left(\frac{5\rho_1}{\rho} + 1\right)\frac{d}{a}\right\}$;

Core theories: $H_d = H_0 \left(1 + 3\,\frac{d}{a}\right)$;

where H_0 is H at surface, H_d is H at depth d, a is radius of the earth, ρ_1 is mean density of rocks to depth d, and ρ is mean density of the earth. From these formulæ, for a depth of 4,800 ft., we calculate

$\Delta H = -26\,\gamma$ (Blackett's theory);
$\Delta H = +11\,\gamma$ (Core theory).

Before comparing the theoretical and observed effects, it is necessary to point out that the lower Witwatersrand system which underlies the underground observation point contains several shale bands which produce considerable anomalies at the surface (Krahmann[2]). Calculations based on Krahmann's values show that the shales produce a relative decrease at depth of not more than $9\,\gamma$. In addition, there were two dykes in the neighbourhood of the observation area which can be expected to give a relative decrease of not more than $5\,\gamma$. The effect of the local geological structure is thus to produce a decrease of at most $14\,\gamma$, and it might be as little as $6\,\gamma$. Allowing for the geological effects:

(1) H (underground) $-$ H (surface) $= -12 \pm 4$, or $-20 \pm 4\,\gamma$;

(2) H (underground) $-$ H (surface) $= -10 \pm 4$, or $-18 \pm 4\,\gamma$.

Even taking our lower limit, the results differ significantly from the core theory. They also differ significantly from the values calculated on the basis of Runcorn's formula. This difference may be accounted for by the fact that Runcorn's formula applies strictly to depth below the mean surface of the whole earth, whereas the mean surface level at Blyvooruitzicht is 5,200 ft. above mean sea-level. It is also possible that there is some geological factor of which we have not taken account. The uncertainty arising from local geological structure should be eliminated by an extended series of observations together with a detailed surface survey, which it is intended to carry out.

In addition to the management and staff of the Blyvooruitzicht G.M. Co., we are indebted to the director, Geological Survey Office, for the loan of instruments.

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Bernard Price Institute of Geophysical Research,
University of the Witwatersrand,
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D. I. Gough
Council for Scientific and Industrial Research,
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[1] Blackett, P. M. S., *Nature*, **159**, 658 (1947).
[2] Krahmann, R., *Trans. Geol. Soc., S. Africa*, **39**, 1 (1936).

Universal Constants in Blackett's Formula

Recently, Blackett[1] has suggested that the formula

$$P = \beta \cdot \frac{G^{1/2}U}{c}$$

represents a fundamental relation between the angular momentum U and the magnetic moment P of a massive rotating body; where G is the gravitational constant, c the velocity of the light and β a dimensionless constant of the order of unity. If the formula were true, it would be a great aid towards finding a theory unifying the gravitational and the electromagnetic field. It is, therefore, interesting to investigate what conditions the formula would impose upon such a future theory. If we assume that the

equations of the new theory can be derived from a Lagrangian, and that the magnetic moment of a rotating body is originated through some cross-terms between the gravitational and the electromagnetic field quantities in the Lagrangian, then it would be found that there must be other universal constants than G and c in the theory.

Generally, the building materials available for forming a Lagrangian in a unified field theory are the various field quantities and the various universal constants. As building operations, there are summation, multiplication, squaring, taking roots, etc. Before commencing each step of summation it must be ensured that the different terms of the sum have the same dimensions. This is the step at which the universal constants enter into the theory. For example, the electromagnetic interaction is generally introduced by replacing the operator $\partial/\partial x^\mu$ by the following sum of operators

$$\frac{\partial}{\partial x^\mu} - \frac{i}{e} A_\mu,$$

where A_μ is the electromagnetic four-potential. In order to make the two terms of the same dimensions, it is necessary to introduce a constant e of the dimensions of charge.

In general, three 'linearly independent' universal constants would enable us to meet any such situation. From three such constants, numerical factors of any dimensions can be formed to ensure the uniqueness of the dimensions of the different terms in a sum. Even in the pioneering attempt of Weyl[2] to unify the gravitational and the electromagnetic field, a constant of the dimensions of charge was implicitly introduced besides G and c. It was introduced when he generalized Christoffel's three index symbols by replacing the operator $\partial/\partial x^\mu$ by the sum

$$\frac{\partial}{\partial x^\mu} + \varphi_\mu,$$

where φ_μ is connected with A_μ through this new constant. It seems that three universal constants would be the minimum number needed in building a unified field theory. If there were only the two constants, G and c, available, the possibilities of building a Lagrangian would be severely limited. Only those combinations of field quantities, the dimensions of which are different from each other by a factor $G^p c^q$, can be used to form a sum where p and q are any rational numbers. On the cross-terms, which are supposed to cause the magnetic moment of a rotating body, the following conditions are then imposed:

(*a*) One condition to ensure that the cross-terms are invariant with respect to co-ordinate transformations. This condition does not depend upon the number of universal constants.

(*b*) Three conditions to ensure that the cross-terms have the dimension cm.$^{-2}$ in the gravitational unit.

(*c*) Three conditions to ensure that the magnetic moment has a dependence on G, c and ρ as given by Blackett's formula, where ρ is the invariant density of the rotating body.

Detailed investigation shows that there exists only a very limited number of cross-terms of different structures which satisfy all the above conditions. Further, none of these cross-terms gives a satisfactory result. If the metric tensor of the gravitational field were not introduced into the cross-terms, the only possible cross-term has the form

$$\frac{G^{3/2}}{c^4} \rho A_\mu u^\mu.$$

u^μ is here the four-velocity of the element of matter. This would give the earth an electrostatic field which is large in comparison with its magnetic field. The metric tensor caused by a rotating body has been given by Lense and Thirring[3] in the first approximation. The non-vanishing, non-diagonal elements have the form

$$\sim \frac{GU}{c^2 R^2},$$

where R is the distance from the centre of the rotating body to the point of observation. If this tensor were introduced into the cross-terms, the resulting theory would give a wrong dependence on the angular velocity of the rotating body.

To free the new theory from some of the above conditions, universal constants other than G and c must be introduced. Since such constants must be in Blackett's formula, they must be contained in the factor β. To make β dimensionless, two constants other than G and c are required, unless we are prepared to introduce a constant of the dimension of $G^p c^q$. Generally, the introduction of universal constants is based on physical principles. The principle of the conservation of charge might be used to introduce one constant. However, it is difficult to imagine what is the other principle which can introduce the other constant. It appears, therefore, that some new physical principle lies behind Blackett's formula.

I wish to express my thanks to Prof. L. Rosenfeld for his most valuable advice. I also wish to thank Prof. P. M. S. Blackett for his kind encouragement and Mr. J. Hamilton for stimulating discussions.

H. Y. Tzu

The University,
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Nov. 10.

[1] Blackett, P. M. S., *Nature*, **159**, 658 (1947).
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[3] Lense, J., and Thirring, H., *Phys. Z.*, **19**, 156 (1918).

Penetration of Magnetic Field into Super-Conductors

We have repeated Casimir's experiment[1] designed to measure the variation with temperature of the penetration depth (λ) of a magnetic field into a massive superconductor. The principle of the experiment is to measure at various temperatures the mutual inductance of two coils wound on a superconducting core; if the magnetic field of the primary coil penetrates slightly into the superconductor, the flux linkage with the secondary coil, and hence the mutual inductance, is slightly greater than if there were no penetration. A small decrease of mutual inductance should therefore be observed as the temperature, and with it, λ, is reduced.

Our experimental arrangement was very similar to that used by Casimir; 75 cycles/sec. A.C. was used in the bridge, and with a measuring current in the primary which produced a peak magnetic field of 0·5 gauss, it was possible to detect changes as small as 0·01 μH, so that the expected effect of order 0·5 μH could be measured with a few per cent accuracy. In his original experiment Casimir found no appreciable effect for mercury; but, as he has kindly informed us, it is likely that this was because

the mutual inductance was mounted on an evacuated quartz tube containing the mercury; as the vapour pressure of the helium bath was lowered to reduce the temperature, the tube would have expanded slightly and thus produced a compensating decrease of mutual inductance. This possibility was avoided in our experiment by leaving the quartz tube open, and the expected increase of mutual inductance was found for both mercury and tin.

Unambiguous results were obtained with a freshly machined tin cylinder and a slowly frozen mercury cylinder, in each case cooled through the transition temperature with the earth's magnetic field compensated. In these circumstances the change of mutual inductance was unaccompanied by any appreciable out-of-phase component. We confirmed Casimir's observation that if the earth's field was uncompensated the change of mutual inductance was greater, but accompanied by a temperature-dependent out-of-phase component; this was probably due to a slight locking-in of flux across the cylinder, which left some resistive patches of normal metal at the surface, of an area inversely proportional to the critical field. We found also that if the tin had been exposed to air for some weeks or was rough, temperature-dependent resistive losses again appeared; and, moreover, the results became sensitive to the strength of the alternating magnetic field of the measuring current.

For tin the variation of $\Delta\lambda = \lambda(T) - \lambda$ (2·1° K.), deduced from the observed change of mutual inductance, with ΔT, the temperature difference from the transition temperature, is shown in Fig. 1. We have plotted also the points obtained by Pippard[2] using a radio-frequency method and by Désirant and Shoenberg (unpublished) from magnetic measurements of tin-filled capillaries; it will be seen that there is fair agreement. For mercury, different results were obtained with two different specimens, but in both cases the values of $\Delta\lambda$ are, within the limits of experimental error, proportional to those obtained by Désirant and Shoenberg[3] from magnetic measurements of bundles of mercury-filled capillaries (Fig. 2). Now Ginsburg[4] has pointed out that the penetration depth could depend on the direction of current flow relative to the crystal axes, and such anisotropy may well be the cause of the discrepancy. It is, in fact, likely that the two mercury specimens were both single crystals or nearly so, but with different crystal orientations; so that the effective penetration depth would have been different in the two specimens. In the experiments of Désirant and Shoenberg, even

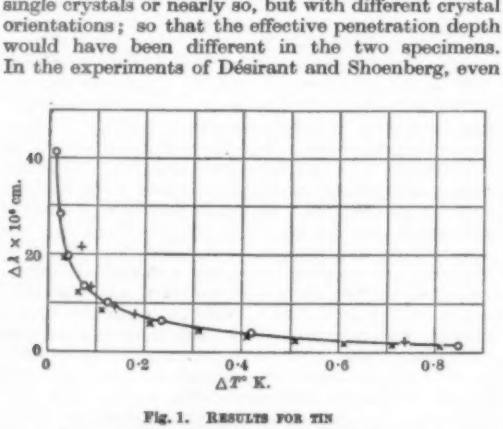

Fig. 1. Results for tin

o—o—o Present results, T_c = 3·711° K.
\+ Désirant and Shoenberg, T_c = 3·738° K.
× Pippard, T_c = 3·711° K.

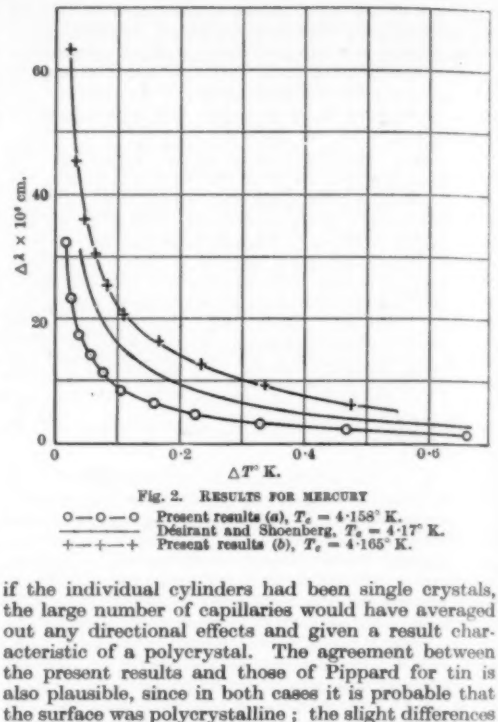

Fig. 2. Results for mercury

o—o—o Present results (*a*), T_c = 4·158° K.
Désirant and Shoenberg, T_c = 4·17° K.
\+—+—+ Present results (*b*), T_c = 4·165° K.

if the individual cylinders had been single crystals, the large number of capillaries would have averaged out any directional effects and given a result characteristic of a polycrystal. The agreement between the present results and those of Pippard for tin is also plausible, since in both cases it is probable that the surface was polycrystalline; the slight differences may be due to slightly different preferred orientations. The fact that for mercury it is only the scale of the $\Delta\lambda - \Delta T$ curve which depends on crystal orientation is reasonable, for in terms of the London theory[5] it would mean that the effective mass of the superconducting electrons varied with the current direction in a crystal, but the ratio of masses in different directions did not vary with temperature (we have to thank Dr. H. London for this observation).

A few experiments were made to see whether there was any evidence for variation of penetration depth with magnetic field, an effect also predicted by Ginsburg[6]. A steady field was superimposed on the small alternating measuring field, but produced no appreciable effect up to about 0·5 of the critical field. For higher fields an apparent rise of penetration depth was obtained which eventually became very great, but since it was accompanied by a rapidly increasing out-of-phase component in the mutual inductance, it is not possible to obtain any definite interpretation; a genuine increase of penetration depth in this region of an amount comparable to the changes with temperature is certainly not excluded.

The experiments are being continued with the aim of obtaining precise data on the anisotropic effects, and to investigate the field dependence of λ.

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D. Shoenberg

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Aug. 15.

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Radiations from Uranium (239) and Neptunium (239)

In a recent communication[1] Slätis has reported on experiments on the β- and γ-radiations from $^{239}_{92}$U and $^{239}_{93}$Np, using magnetic analysis and absorption methods for the two types of radiation respectively.

For $^{239}_{92}$U the nuclear γ-radiation of 76 ± 3 keV. energy, first reported by Feather and Krishnan[2], has been confirmed, and its energy fixed as 73·2 ± 0·3 keV. by measurements on the line spectrum of *L*- and *M*-photo-electrons. Also, there is satisfactory agreement between the new value for the energy-limit of the main β-spectrum (1·12 MeV.) and the value (1·20 ± 0·02 MeV.) deduced from the absorption curve. But a serious discrepancy is evident between the conclusions indicated by the level scheme of Fig. 2 of Slätis's paper and the earlier results. The level scheme in question indicates that a γ-radiation of energy 870 keV. is emitted in cascade with the 73 keV. transition. Now it would appear that the only evidence for the assumption that a quantum of 870 keV. radiation is emitted in nearly every disintegration (as distinct from occasionally) is in the results of the analysis of the continuous β-spectrum by the Fermi method. This analysis is reported to yield a second high-energy component of feeble intensity and limiting energy 2·06 MeV. No such component was detected by the absorption method (it would have been a simple matter to have detected a high-energy component of intensity 0·05 in this way); furthermore, the published results of Feather and Krishnan set an upper limit of about the same magnitude (0·05) to the emission probability of a possible 870 keV. quantum.

We also observed a second γ-radiation, and estimated its intensity at about 0·10 per disintegration on the assumption that the quantum energy was of the order of 300–600 keV. If the energy were assumed to be twice as great, the calculated intensity would be roughly halved. It would seem, therefore, that the level scheme of Slätis's Fig. 2 cannot be substantiated, and that the total disintegration energy of $^{239}_{92}$U is 1·20 ± 0 05 MeV., not 2·06 MeV. The β-spectrum which was observed to have the latter energy limit must, in this case, have another origin.

As regards $^{239}_{93}$Np, it is interesting to compare the results of the Fermi analysis of Slätis with unpublished results which I obtained by the absorption method early in 1941[3]. Analysing the complete absorption curve of the β- and γ-radiation by standard methods[4], it was then concluded that the β-radiation of $^{239}_{93}$Np was constituted as follows:

	Energy (keV.)	Intensity
Photo-electrons	—	~ 0·6
Partial spectrum 1	140 ± 25	~ 0·2
" " 2	400 ± 20	0·7
" " 3	630 ± 20	0·1
" " 4	> 1000	< 0·05

Slätis's analysis leads to maximum energies of 288, 403, 676 and 1,179 keV., and, as concerns intensities, the preliminary report merely indicates that the second partial spectrum with end-point at 403 keV. is the most intense.

The general similarity of the results is not without significance, particularly in relation to the claim that, under suitable control, the absorption method can be of real use in the analysis of complex β-spectra, so long as sufficiently detailed observations are made. It might be mentioned in this connexion that the absorption measurements on the β-radiation of $^{239}_{93}$Np were made using sources of less than 10^{-4} mC. strength obtained from the decay of $^{239}_{92}$U produced by the (*d*, *p*) reaction with uranium on the Cambridge cyclotron. Chemical separations were made under the direction of Dr. E. Bretscher, to whom belated thanks are now recorded.

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Oct. 28.

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Autoradiograph Technique

Experiments aiming at an improvement of the resolution obtained with the autoradiograph technique were recently carried out, and a short outline of the methods used is given here.

15 μC. of radioactive iodine (I^{131}) were injected subcutaneously into a rat (wt. 125 gm.). The thyroid was fixed in alcohol and sections 5 μ thick were cut after embedding in paraffin. Fig. 1 shows a photomicrograph of a stained section of the thyroid. After dissolving the paraffin, sections were brought into contact with the photographic film or plate, and the two pressed together in a printing frame and left there for a suitable time of exposure. The sections were not coated with 'Colloidin' before exposure. The film or plate was then developed and fixed[1,2]. Of the various emulsions tried, Ilford Line film showed the best resolution. Fig. 2 shows an autoradiograph made from the section shown in Fig. 1 before staining, the well-known fact that iodine is concentrated in the colloid of the thyroid follicles appearing clearly in the autoradiograph. Colloid particles 10 μ apart can still be distinguished as separate units; if the distance is 15 μ the separation is very clear. The exposure is about twenty times that needed for a fast X-ray film.

In order to improve resolution, stripping emulsion was removed from its base and immersed in water. A slide carrying a section was placed underneath the emulsion, both lifted out of the water and dried quickly in front of a fan. The slides were then left

Fig. 1

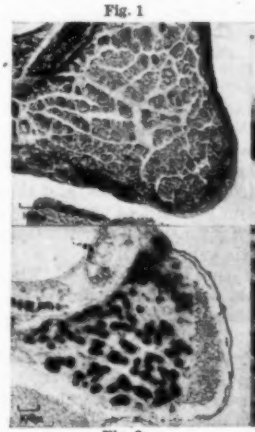

Fig. 2

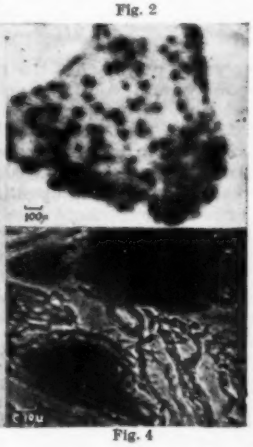

Fig. 3

Fig. 4

in a light-proof container and developed and fixed after a suitable interval. The original section and the autoradiograph are superimposed and can be viewed simultaneously. Fig. 3 shows a photomicrograph, and the improved resolution can be judged by comparison with Fig. 2. Determination of the location of the radioactive substance will be facilitated as both cells and autoradiograph can be viewed simultaneously. Methods of staining through the covering layer of gelatine were tried but have so far been unsuccessful. A photomicrograph taken with the phase-contrast microscope (Fig. 4) depicts the ring of cells around the colloid with sufficient detail for judging the location of the radioactive material. The resolution of the autoradiograph can also be judged from this illustration.

Ilford half-tone, thin film, dry stripping emulsion was found very suitable. The exposure is about four times that needed for a fast X-ray film. Specially prepared slides which prevent lifting off of the emulsion during processing were supplied by Kodak, Ltd.

I wish to thank Dr. I. Doniach, of the British Post-graduate Medical School, for the histological work done; Dr. A. F. W. Hughes, of the Strangeways Laboratory, Cambridge, for preparing the photomicrograph Fig. 4; and Mr. C. Waller, of Messrs. Ilford, Ltd., and Dr. R. H. Herz, of Messrs. Kodak, Ltd., for much helpful discussion.

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Entropy Fluctuations in Liquid Helium II and the Rayleigh Line

It is known[1] that in the scattered light spectra of liquids the Rayleigh line exhibits an undisplaced component of the same frequency as the exciting light and two displaced components on either side of the undisplaced line. It was shown by Landau and Placzek[2] that the intensity I_u of the undisplaced component and the sum of the intensities $2I_v$ of the displaced components is given by

$$\frac{I_u}{2I_v} = \frac{C_p - C_v}{C_v},$$

where C_p and C_v are the specific heats at constant pressure and constant volume respectively. The Landau – Placzek relation accords with experiment reasonably well for several liquids. Recently, Gross[3] has given an interesting derivation of the Landau–Placzek relation. He has shown that the undisplaced component is caused by entropy fluctuations, and the displaced components arise on account of the density fluctuations. The density fluctuations, constituting as they do the Debye elastic-vibrations, travel in a liquid with the velocity of the Debye-waves. The entropy fluctuations, on the other hand, can be regarded as stationary, and hence give rise to the undisplaced component.

The present note is concerned with an application of the theory of Landau and Placzek, and Gross, to liquid helium II. As has been shown by Landau[4] in liquid helium II we have to deal with two velocities of sound waves, a result which has been confirmed by the experiments of Peshkov[5]. One wave is the normal one, that is, due to density fluctuations, and the second sound wave is due to entropy fluctuations. In liquid helium II, the entropy fluctuations are no longer stationary but travel with a velocity which is zero at the λ-point, increases with increasing temperature (T) and approaches the value $C_1/\sqrt{3}$ as $T \to 0$, where C_1 is the velocity of the density waves (normal sound). It therefore follows that the Rayleigh line in liquid helium II should show a structure radically different from that in other liquids. Instead of the undisplaced component and the two displaced components there should arise (as $T \to 0$) four displaced components and no undisplaced component. The experimental observation of the scattering of liquid helium II, if accomplished, will throw an interesting light on the existence of normal and super-fluid liquid in helium II.

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A. G. Chowdri

University,
Delhi.
July 7.

[1] Gross, E., *Nature*, **126**, 201 (1930); **129**, 722 (1932).
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Third-Order Elastic Coefficients of Crystals

It is well known that the number of independent second-order elastic coefficients required to describe the behaviour of cubic crystals is three, irrespective of the class to which they belong, whereas the corresponding number for isotropic bodies is two. That a crystal of the cubic system differs from an isotropic body in another important respect, namely, its photo-elastic behaviour, was discovered by Pockels. Pockels, however, as in the case of elasticity, made no distinction between the five classes of crystals coming under the cubic system, but assigned three coefficients only for all of them. Contrary to this, one of us[1] showed, by a different method based on group theory, that the T and T_h classes of the cubic system require four coefficients for the description of their photo-elastic behaviour, whereas the other three classes T_d, O and O_h require only three. This prediction has been verified by us experimentally by working with crystals of potassium alum[2].

Recent work of Francis Birch[3] on the theory of finite strain is of interest in this connexion because he has reported that the number of third-order coefficients required to describe the behaviour of cubic crystals is eight for the T, T_h and T_d classes and six for the O and O_h classes. Birch has shown that the maximum number of such coefficients permissible in a triclinic crystal is 56. The method developed by us is of such wide applicability that the numbers of coefficients required to describe any physical property can be easily calculated for all the crystal classes, and this has been done in papers published elsewhere[4].

We have now extended this method to the case of finite strain. The notation used is the same as that adopted in our earlier papers. The character of the matrix relating to the transformation of the 56 coefficients under a general symmetry operation consisting either of a rotation through φ or of a rotation through φ accompanied by a reflexion works out to be

$64\cos^6\varphi \pm 32\cos^5\varphi - 48\cos^4\varphi \mp 8\cos^3\varphi + 16\cos^2\varphi$. Where alternatives occur, the upper or the lower sign should be used respectively for rotation and a rotation reflexion. Using this character and the general formula derived in the earlier papers, the numbers of coefficients for each class are obtained as 56 for C_1 and C_i; 32 for C_s, C_2 and C_{2h}; 20 for C_{2v}, D_2 and D_{2h}; 16 for C_4, S_4 and C_{4h}; 12 for C_{4v}, D_{2d}, D_4 and D_{4h}; 20 for C_3 and S_6; 14 for C_{3v}, D_3 and D_{3d}; 12 for C_{3h}, C_6 and C_{6h}; 10 for D_{3h}, C_{6v}, D_6 and D_{6h}; 8 for T and T_h; 6 for T_d, O and O_h.

These results show that there is a distinction, as in the case of photo-elasticity, between the T and T_h classes of the cubic system on one hand and the T_d, O and O_h classes on the other. They confirm the findings of Francis Birch in all respects except in the T_d class, for which he states that eight coefficients are required. This is presumably due to his not having taken into account a four-fold rotation reflexion axis which this class possesses.

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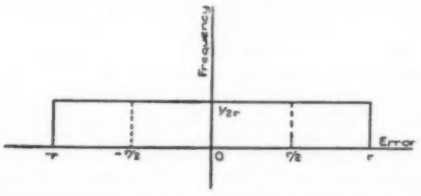
Over-estimation of Probable Errors

This note is to point out that the use of the formula usually given for the combination of probable errors is invalid when the observed quantities are subject to scale errors only, as, for example, when the probable error of a single observation is estimated as $\frac{1}{4}$ least count of a vernier.

Scale errors arise from the finite size of scale intervals, inscribed or visually estimated. If a scale is divided into inches and tenths and an observer estimates a further decimal place by eye, a reading such as 7·37 in. means that the 'true' length lies between 7·365 in. and 7·375 in.; that is, an error is being made and its value may be anywhere between − 0·005 in. and + 0·005 in. A large number of such readings would give the distribution of errors shown where the working interval is taken as $2r$; the form is described as 'rectangular', and its standard deviation is $2r/\sqrt{12}$. This, of course, refers to an idealized problem, rather more extreme than occurs in practice.



The 'probable error' is defined as the value of the deviation beyond which half the observations lie; in the case of the rectangular distribution it is $r/2$; the probable error of a reading of a vernier scale with least count 0·01 in. is 0·0025 in. (On the other hand, if repeated observations of a quantity give a standard deviation of σ, and the errors are assumed normally distributed, the probable error of a single observation is $0{\cdot}6745\sigma$.)

Let z be a linear function of $u, v, w, \ldots$, say, $z = au + bv + cw + \ldots$, then the error in z due to errors in $u, v, w, \ldots$ is

$$p^2 = a^2p_1^2 + b^2p_2^2 + \ldots . \qquad (1)$$

where p is probable error of z, p_1 that of u, p_2 that of v, etc. This rule is valid for normal distribution of errors in $u, v, w, \ldots$; but errors following a rectangular distribution cannot be combined in this way because the error of a linear function of a number of such variables has not itself a rectangular distribution. Hence its probable error forms a different fraction of the range, or more correctly, of the standard deviation. The difficulty arises because the probable error depends on the form of the distribution, and no simple method exists for combining probable errors of different types of distribution. It is quite different with the standard deviation, which measures the dispersion of the distribution, and combines by a simple rule for very general forms of the component distributions[1]. Thus, if $\sigma, \sigma_1, \sigma_2, \ldots$ are standard deviations of $z, u, v, \ldots$ respectively, then

$$\sigma^2 = a^2\sigma_1^2 + b^2\sigma_2^2 + c^2\sigma_3^2 + \ldots \qquad (2)$$

This equation readily yields (1) when errors in $u, v, w, \ldots$ are distributed normally. On the contrary, if errors in $u, v, w, \ldots$ are scale errors only, estimated from working intervals $2r_1, 2r_2, 2r_3, \ldots$, the respective standard deviations are $2r_1/\sqrt{12}$, $2r_2/\sqrt{12}$, $2r_3/\sqrt{12}, \ldots$ and (2) gives

$$\sigma^2 = \tfrac{1}{3}(a^2r_1^2 + b^2r_2^2 + c^2r_3^2 + \ldots). \qquad (3)$$

It is known that the distribution of the sum of a number of rectangularly distributed variables tends to normality[2] fairly rapidly as the number increases, so that σ will be the standard deviation of a nearly normal distribution, in which case $p \doteqdot 0{\cdot}6745\sigma$. Applied in the same problem, (1) would have yielded

$$p^2 = a^2(\tfrac{1}{2}r_1)^2 + b^2(\tfrac{1}{2}r_2)^2 + c^2(\tfrac{1}{2}r_3)^2 + \ldots = \tfrac{1}{4}\sigma^2, \text{ or } p = 0{\cdot}8660\sigma. \qquad (4)$$

This represents an over-estimation by 28 per cent on the value obtained from (3), but, as will be shown below, the latter is itself slightly in defect.

The only treatment of errors of interval to my knowledge is that given by Gibbs[3], where approximations are obtained for the probable error of z with $a, b, c, \ldots$ restricted to the values + 1 and $2r_1 = 2r_2 = 2r_3 = \ldots 1$; the method over-estimates p. An exact treatment may be based on the cumulated probability function for the sum of n rectangular variables

$$\frac{1}{n!}\sum_{x \geqslant j}(-1)^j\binom{n}{j}(x-j)^n. \qquad (5)$$

It is of interest to compare the approximations based on (3), and the fallacious values obtained from (1), with the exact probable errors based on (5) (probable errors given in terms of interval).

No. of variables (n) =	1	2	3	4	5	6	7
Method of estimation of probable error:							
Exact (5)	0·250	0·293	0·353	0·403	0·447	0·487	0·525
Normal (3)	0·195	0·276	0·337	0·390	0·435	0·477	0·515
Fallacious (1)	0·250	0·353	0·433	0·500	0·559	0·612	0·661
Under-estimation by (3), per cent	22·0	6·2	4·7	3·2	2·8	2·1	1·9
Over-estimation by (1), per cent	0	20·5	22·7	24·1	25·1	25·7	25·9

When more than three errors are combined by method (3), the departure from the correct estimate is so slight that it can be ignored; but the over-estimation by formula (1) is serious in all cases.

The essential point is this. If the probable error of a variable directly measured is calculated from the standard deviation of repeated measurements (assumed normally distributed), equation (1) may be used to calculate the probable error of a linear function of such variables. On the other hand, if the direct measurements are not repeated but have their probable errors estimated from the working intervals, equation (1) will over-estimate the probable error of the calculated result.

When the magnitude of the scale error differs among the variables, formula (5) must be modified, and the resultant probable error depends on the relative magnitudes of the scale errors. The net result is that equation (3) will not be far out when the scale errors are of about the same magnitude; but when they differ widely, the largest dominates the precision of the result and the rest may be ignored.

It should be noted again that these difficulties arise only when experimenters use 'probable' errors, now generally discarded in applied statistics. It will be a welcome reform in the 'exact' sciences when standard deviations and standard errors are accepted as conventional.

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Relationship Between the Dissociation Constants of Unsymmetrical Dicarboxylic Acids

The correlation of the first and second dissociation constants of symmetrical dicarboxylic acids with the distance apart of the ionizing groups is well known. An experimentally convenient correlation has not previously been proposed for unsymmetrical acids. For symmetrical acids the relationship may be represented by the equation

$$\log_{10}\frac{K_a'}{\delta K_a''} = \frac{N_0\varepsilon^2}{2{\cdot}303\,RTD_Br},$$

where K_a' and K_a'' are respectively the first and second measured thermodynamic dissociation constants, δ is a symmetry number (in this case 4), N_0 the Avogadro number, ε the electronic charge, R the gas constant, T the absolute temperature and D_B the effective dielectric constant for the space between the two ionizing groups separated by the distance r. For unsymmetrical acids a solution of the problem may be obtained by the following considerations.

In the case of any unsymmetrical dicarboxylic acid HA_1A_2H we write

$$K_a = \frac{a_{H^+}\cdot[A_1A_2^-]\cdot f_-}{[HA_1A_2H]\cdot f_0} \text{ and } K_a^{II} = \frac{a_{H^+}\cdot[A_1A_2H^-]\cdot f_-}{[HA_1A_2H]\cdot f_0}$$

for the thermodynamic dissociation constants corresponding to the two alternative steps for the first dissociation; and

$$K_a^{III} = \frac{a_{H^+}\cdot[A_1A_2^{=}]\cdot f_=}{[HA_1A_2^-]\cdot f_-} \text{ and } K_a^{IV} = \frac{a_{H^+}\cdot[A_1A_2^{=}]\cdot f_=}{[A_1A_2H^-]\cdot f_-}$$

for the corresponding two alternative routes for the second dissociation. In these expressions f_0, f_- and $f_=$ are the appropriate activity coefficients for the undissociated acid, for the monovalent anions and for the divalent anion respectively.

Now if the unsymmetrical acid be subjected to potentiometric titration we have, for the addition of B equivalents of strong base,

A = molarity of the acid = $[HA_1A_2H] + [HA_1A_2^-] + [A_1A_2H^-] + [A_1A_2^{=}]$ and

$B + [H^+] = [HA_1A_2^-] + [A_1A_2H^-] + 2[A_1A_2^{=}] + [OH^-]$.

If we then define

$\alpha = B + [H^+] - [OH^-] = [HA_1A_2^-] + [A_1A_2H^-] + 2[A_1A_2^{=}]$

$\beta = A - B - [H^+] + [OH^-] = [HA_1A_2H] - [A_1A_2^{=}]$

and $\gamma = 2A - B - [H^+] + [OH^-] = 2[HA_1A_2H] + [HA_1A_2^-] + [A_1A_2H^-]$

it is readily shown that

$$a_{H^+}\cdot\left(\frac{\alpha}{\gamma}\right)\cdot\frac{f_=}{f_0} = (K_a^{I} + K_a^{II})\cdot a_{H^+}\cdot\left(\frac{\beta}{\gamma}\right)\cdot\frac{f_=}{f_-} + \frac{(K_a^{I} + K_a^{II})(K_a^{III}\cdot K_a^{IV})}{(K_a^{III} + K_a^{IV})}$$

The constant term in this equation may be simplified by the considerations that

$$K_a^{I}/K_a^{IV} = \exp N_0\varepsilon^2/RTD_Br \text{ and } K_a^{II}/K_a^{III} = \exp N_0\varepsilon^2/RTD_Br,$$

where the symbols have the significance previously employed. The equation then reduces to

$$a_{H^+}\cdot\left(\frac{\alpha}{\gamma}\right)\cdot\frac{f_=}{f_0} = (K_a^{I} + K_a^{II})\cdot a_{H^+}\cdot\left(\frac{\beta}{\gamma}\right)\cdot\frac{f_=}{f_-} + K_a^{I}K_a^{II}\cdot\exp -N_0\varepsilon^2/RTD_Br.$$

Clearly this may be plotted as a linear equation, and if either K_a^{I} or K_a^{II} be known, then the electrostatic term $\exp -N_0\varepsilon^2/RTD_Br$ may be evaluated and used for calculation of r. For this purpose it is only necessary to determine the dissociation constant of one of the mono-methyl esters, say, of the acid.

If $K_a^{I} = K_a^{II}$ and $K_a^{III} = K_a^{IV}$, that is, if the acid be symmetrical, it is readily shown that the equation reduces to a form which has been successfully employed by Speakman[1] for symmetrical dicarboxylic acids.

Application of the equation for unsymmetrical acids to problems in molecular structure will be reported elsewhere.

I thank Prof. H. V. A. Briscoe for his interest in these derivations.

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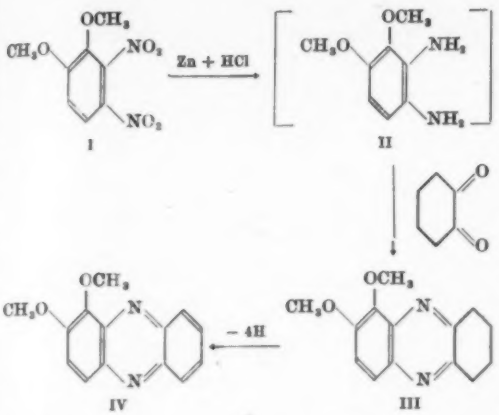
Phenazine Synthesis

Continuing the researches of Clemo and McIlwain[1] on the structure of the pigment of *Chromobacterium iodinum*, we are engaged in the synthesis of phenazines. In view of the recent communication of Slack and Slack[2], describing the preparation of 1 : 2-dimethoxyphenazine, we wish to put on record an independent synthesis using the method of Clemo and McIlwain[3].



An alcoholic solution of 3 : 4-dinitroveratrole[4] (I) was reduced by the action of zinc and hydrochloric acid, and the final solution of the reduction product was condensed with cyclohexane-1 : 2-dione[5], without attempting to isolate the pure free base (II). The resulting 1 : 2-dimethoxy-5 : 6 : 7 : 8-tetrahydrophenazine (III) crystallized from light petroleum (b.p. 40–60°) in straw-coloured needles, m.p. 82–83° (found: C, 69·0; H, 6·6. $C_{14}H_{16}O_2N_2$ requires C, 68·9; H, 6·6 per cent).

Dehydrogenation of (III) in *p*-cymene solution using palladium charcoal gave 1 : 2-dimethoxyphenazine[6] (IV), which crystallized from light petroleum, b.p. 80–100°, in orange-yellow blades, m.p. 138–139° (found: C, 70·0; H, 5·4. $C_{14}H_{12}O_2N_2$ requires C, 70·0; H, 5·0 per cent).

Attempts to prove the structure of the bacterial pigment by synthesis are in progress and a full account will be published elsewhere.

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Thermal Decomposition of Organic Nitrates

The kinetics and mechanism of the thermal decomposition of organic mono- and poly-nitrates have been studied during recent years by Bawn and Wiseman[1], A. J. B. Robertson[2] and more extensively by me[3]. Studies on the overall decomposition in liquid and vapour phases suggest strongly that fission of O—N bonds with formation of NO_2 is the primary process, while I have shown[3] that during the very early stages of decomposition of a wide range of organic nitrates, in which the occurrence of secondary reactions is prevented, nitrogen is eliminated from the molecule wholly as NO_2. These observations and the identification of aldehydes among the decomposition products indicate that, as suggested earlier by Bawn[1], the mechanism postulated by Appin *et al.*[4] for methyl nitrate applies to organic nitrates in general, namely:

$$RCH_2O - NO_2 \rightarrow RCH_2O^- + NO_2$$
$$RCH_2O^- \rightarrow \tfrac{1}{2}RCHO + \tfrac{1}{2}RCH_2OH,$$

followed by oxidation-reduction reactions between the products.

The pressure/time curves for the overall decomposition of a wide range of these nitrates conform to the first-order relationship over their greater part, but temperature-independent factors are usually abnormally high, ranging from $10^{14.7}$ for *n*-propyl nitrate to $10^{20.6}$ for mannitol hexanitrate, while apparent activation energies range from 34 to 47 kilo-cal./mole. The magnitude of these temperature-independent factors has aroused considerable speculation, particularly as to the possible incidence of chain reactions, but no satisfactory explanation has been found. Thus Roginski and Sapozhinkoff[5] showed that the rates of decomposition of nitroglycerine in the liquid state and in dilute solution were the same, and also that the usual chain-breakers are without effect; I find[3] no large difference between decomposition-rates of other polynitrates in the vapour and liquid phases.

The placing of theoretical interpretations on such kinetic constants should, however, be approached with caution, since more than one reaction occurs during decomposition, particularly with polynitrates, the apparent order of reaction being controlled by the fission of O—N bonds, which is a first-order process.

It is improbable, however, that such considerations will account wholly for the abnormally high *B* factors. This is confirmed by my work on the very early stages of the decomposition of a range of organic nitrates, where secondary reactions are prevented[3]. Here the extent of the decomposition of polynitrates studied is so small that it is reasonable to assume that fission of only one O—N bond is involved. Typical results are shown in the accompanying table.

Nitrate	Temp. (°C.)	*k*
Ethylene glycol dinitrate	85–105	$10^{15.2}$ exp $-$ 39000/*RT* sec.$^{-1}$
Trimethylene glycol dinitrate	85–110	$10^{16.2}$ exp $-$ 38100/*RT* sec.$^{-1}$
Propylene glycol dinitrate	80–100	$10^{15.2}$ exp $-$ 37400/*RT* sec.$^{-1}$
Nitroglycerine	75–105	$10^{17.1}$ exp $-$ 40300/*RT* sec.$^{-1}$
Trimethylol-nitromethane trinitrate	75–95	$10^{15.9}$ exp $-$ 36400/*RT* sec.$^{-1}$

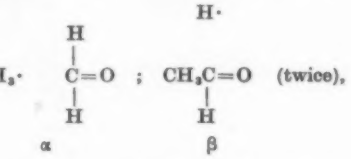
In general, temperature-independent factors are still higher than those normally associated with first-order reactions. The most probable explanation of this, since evidence so far does not support the postulation of long chains, is that appreciable positive entropies of activation due to restricted rotation about C—C bonds are associated with these reactions. Thus on the basis of the activated-complex theory[6], the 'temperature-independent' factor in the Arrhenius equation for a rapid first-order reaction is identified with the expression

$$e \cdot \frac{kT}{h} \cdot \exp \Delta S^{\ddagger}/R,$$

where $\Delta S^{\ddagger}$ is the entropy of activation. Construction of models of polynitrate molecules shows that in the position of closest approach, mutual dipolar repulsion of nitrate groups is probably large enough to set up an appreciable potential barrier to free rotation about

C—C bonds in the initial state. This view is to some extent supported by the results of de Kreux[7] on the dipole moments of organic nitrates. Such a barrier between two nitrate groups should largely disappear in the transition state when one O—N bond is broken, thereby resulting in an appreciable positive entropy of activation.

In the present work it has been shown that the order of stabilities of O—N bonds in the alkyl nitrates is methyl > ethyl > n-propyl. This can be explained on the basis of reduction of the O—N bond-energy by the extra resonance-energy of the RCH_2O— radical due to a hyperconjugation effect similar to that postulated by Polanyi and Butler[8] for the alkyl halides. Thus the CH_3CH_2O— radical has the extra resonance forms



the α-form being more probable than the three extra resonance forms in the corresponding CH_3O— radical because of the difference between the C—C and C—H bond energies. Further structural effects observed by me, for example, the de-stabilizing effect of a second nitrate group and of electro-negative groups, can similarly be explained.

Details of this work, which was carried out during 1941–45, will be published elsewhere together with results of more work now in progress in this field.

This communication is published with the approval of the Chief Scientist, Ministry of Supply.

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Reduction of Aniline in Ammonia

In a recent paper by Watt, Knowles and Morgan[1] on the course of reduction in liquid ammonia the following statement is made: "In view of the results reported by Wooster[2] it is surprising that reduction of nitrobenzene by the sodium-methanol combination yielded aniline and not dihydroaniline—". Unpublished work by me has shown that aniline is reduced by sodium and methanol in liquid ammonia, as would be expected by analogy with the reduction of dimethylaniline[3], which Watt, Knowles and Morgan do not mention. If the reduction is carried out rapidly, the product is a dihydroaniline, probably the 2 : 5-, since acid hydrolysis leads to *cyclo*hexenone. Slow reduction, however, gives chiefly a tetrahydroaniline, probably the 1 : 2 : 5 : 6-; 3 : 5-dinitrobenzoyl derivative, m.p. 198° (found: C, 53·3; H, 4·6. $C_{13}H_{13}O_5N_3$ requires C, 53·6; H, 4·5 per cent). Its melting point is depressed by admixture with the derivative from aniline, m.p. 235°, and it cannot be an enamine since it is stable to mineral acid. There is little reduction of dimethylaniline past the dihydro-stage under the conditions used here, namely, excess of alcohol, so that the further reduction of dihydroaniline is probably due to isomerization of the enamine to the imine:

$$—CH=C(NH_2)— \rightarrow —CH_2C(=NH)—;$$

and reduction of the imino-group, rather than to conjugation of the nuclear bonds and reduction of the conjugated system. The latter reaction should lead in any event to an enamine, which would give on acid hydrolysis *cyclo*hexanone, as is, in fact, the case with dimethylaniline in the presence of excess sodium[3]. The facile rearrangement of enamines to imines probably explains the formation of, for example, tetrahydroquinoline rather than dihydroquinoline by reduction of quinoline with sodium and alcohol.

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White-eyed Mutants of Diptera

Two recent papers[1,2], as well as an older one[3], compare white-eyed mutants found in *Culex*, *Calliphora* and *Phormica*, respectively, with the white-eyed types long known in *Drosophila*. Since in no *Drosophila* species is more than one single-gene difference known that will give rise to a white eye, it is concluded that these types in other Diptera represent mutations corresponding to the white of *Drosophila*.

There is a special reason why this conclusion cannot be accepted. It has been known for some time that there are two distinct pigments, a red and a brown, in the eye of the wild-type *Drosophila*. The red pigment is absent in the brown mutant; the brown is absent in the vermilion, cinnabar and scarlet mutants; both are absent in white. The results of Becker[4] show that the red pigment is absent in *Calliphora*—in which, therefore, the wild type is like the brown mutant of *Drosophila*. This appears to be the usual condition in insects; the red pigment is apparently present in all Drosophilidæ that I have examined, but seems to be present in only a few of the related families. It should, therefore, not be possible to distinguish the white, vermilion, cinnabar and scarlet mutants in more remote families unless special methods are used.

There is available a method for further differentiation here, namely, the study of the hormones involved in eye-pigment production. As is well known, the white and scarlet mutant types of *Drosophila* are not affected by hormones; but there are two separate hormones involved in the production of the brown pigment, of which vermilion lacks one, cinnabar the other[5]. It has been shown that these hormones are not species-specific in their activity, and cross-tests with *Drosophila* have been made with mutant eye-colours in other insects. In this way it has been shown that the mutant 'ivory' (and its allele 'orange') in the hymenopteron *Habrobracon* is

due to a deficiency in the hormone that is lacking in cinnabar *Drosophila*[6], and that there is a similar correspondence in two mutant types of Lepidoptera: the 'red' of *Ephestia* corresponds to vermilion[7], and the 'white-1' of *Bombyx* corresponds to cinnabar[8].

It will be noted that one of these types is in fact white, while another one is only slightly pigmented—as might be expected if a single eye-pigment is present.

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Excessive Hydration in an Animal with an Open Type of Circulation

A CONDITION of excessive hydration, with great distension of the body, has been observed in the aquatic crustacean *Asellus*, and is interesting since (1) the relatively rigid crustacean exoskeleton might have been expected to preclude such a condition, and (2) in the open type of circulation, of Crustacea, there is no barrier corresponding to the capillary wall which, in an animal with closed circulation, plays an important part in the etiology of the œdematous type of excess hydration, that is, distension of the tissue spaces with fluid[1].

The condition in *Asellus* has been observed very occasionally in Nature, not infrequently in laboratory stocks, and in 30 per cent of individuals undergoing regeneration of limbs in unfavourable external media. A similar condition develops, particularly in young individuals, during histological fixation. It has been induced experimentally by sealing the surface of the gills (respiratory pleopods) with 'Celloidin'.

The incipient condition affects the gills only, their exoskeleton being particularly thin and pliable. Later, the whole body is affected, distension occurring by the normally flattened body and gills becoming increasingly circular in cross-section and by elongation of the body through the straightening out of the normally infolded intersegmental membranes. The latter process is most marked along the dorsal surface so that the body becomes flexed ventralwards, rigidly, and the limbs of the mid-thoracic segments do not touch the substratum. Muscular movements, depending on normal intersegmental mobility, eventually become impossible. There is probably no stretching of the material of the exoskeleton. Excessively hydrated animals experience difficulty in ecdysis, the condition preventing the necessary contraction of the body[2].

Individuals survive for periods up to sixteen days after the development of visible distension. The amplitude, rate and rhythm of the heart remain apparently normal until the final stages when there is slowing, decreased amplitude, irregular rhythm and asynchrony between the two ends of the elongated organ.

The condition is relieved immediately throughout the body by permitting hæmorrhage, either by piercing the body-wall or by removing a limb. There is an apparent return to complete normality and the distension is clearly hydræmic and not œdemic in nature. The body-wall is not passively distended, but develops considerable tension. Normal muscular movements are restored immediately by deflation. The relief is temporary (1–3 hours).

The distension may be reduced by hypertonic concentrations of such solutes as sodium chloride, sugar and gum arabic in the external medium, the large molecules being the most effective in equimolar concentrations. Relief persists for 12–24 hours. Moderate desiccation, of course, reduces the condition.

Distension due to histological fixation, a familiar problem, may be avoided by opening up the body cavity before fixation or by dropping the animals into water at 65° C. for 15 sec. as a preliminary to chemical fixation. Apart from the avoidance of distension, the histological picture is considerably improved by these methods. Heat-treatment denatures the proteins (judged by opacity) throughout the body and presumably inactivates a water-absorbing mechanism. The most powerful chemical fixatives fix only exposed and thin-walled structures, such as the gills, the rate of penetration into the body being too slow to effect fixation or to prevent fluid distension. It seems probable that the gills are important in the control of water balance.

In such Crustacea as amphipod *Mimonectes*, a pronounced distension of the body would seem to be a normal adaptation to a specialized mode of life.

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Aug. 11.

[1] Wright, S., "Applied Physiology" (Oxford, 1945), see pp. 563–67.
[2] Needham, A. E., *Nature*, **158**, 667 (1946).

Morphology of *B. megatherium* Bacteriophage

MUCH attention is at present being paid to the fundamental problem of the relationship between the viruses and their host cells. The action of bacteriophage on bactéria is in many ways analogous to the action of a virus upon an animal cell. Since the bacterium-bacteriophage system is the less complex, and more amenable to electron microscopical study than living cells, the mechanism of bacteriophage action is a subject of active research.

It has already been shown by Luria, Delbrück and Anderson[1] that the T_2 coliphage is sperm-shaped, and hence easily identified in electron micrographs. The *Salmonella pullorum* and *Rhizobium leguminosarum* bacteriophages have also been shown to have a similar morphology[2,3]. In this laboratory, we have recently found that the No. 1 phage of *B. megatherium* also possesses a readily identified sperm-like structure. The large size of the *megatherium* bacillus makes it readily visible in the light microscope under oblique illumination, and the action of phage on this organism has already been discerned with the light microscope[4].

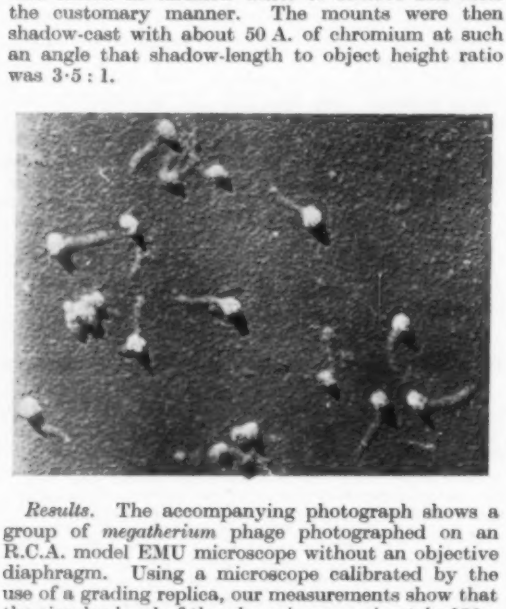
Material. Cowles described[4] the characters of two phages, isolated from sewage and designated No. 1 and No. 2, active against seven different strains of *B. megatherium*. The phages were inactivated by heating to 75° C. for 10 min. Further observations[5] on strain of *B. megatherium* No. 899 (De Doreen de Jong) showed that bacteriophage could be demonstrated in filtrates of cultures developed from spores heated to 90° C.

A culture of *B. megatherium* No. 1 isolated in 1904 and a quantity of phage No. 1 were received from

Dr. Cowles, and concentrated preparations of phage were prepared as follows.

Technique. Broth culture of *B. megatherium* incubated at 37° C. for 5 hours was inoculated on 2 per cent nutrient agar plates, and allowed to dry. Thereafter 1/200 c.c. volumes of phage were placed on the surface of the inoculated media, allowed to dry, incubated at 37° C. for 24 hours, and lysed areas transferred with a loop to broth. The suspension of phage was centrifuged at 2,500 r.p.m. for 30 minutes, to deposit vegetative forms, and the supernatant removed. After repeating this procedure eight times, a concentration of No. 1 phage active to a dilution of 10^{-6} against *B. megatherium* No. 1 was eventually attained.

This suspension was centrifuged in narrow flat-type tubes (3 mm. by 10 cm.) in the Swedish angle centrifuge at 4,200 r.p.m. for 2 hours, and the deposit was resuspended in a few drops of saline. Electron microscope mounts were made on 'Formvar' films and rinsed in distilled water to remove salt after the customary manner. The mounts were then shadow-cast with about 50 A. of chromium at such an angle that shadow-length to object height ratio was 3·5 : 1.



Results. The accompanying photograph shows a group of *megatherium* phage photographed on an R.C.A. model EMU microscope without an objective diaphragm. Using a microscope calibrated by the use of a grading replica, our measurements show that the circular head of the phage is approximately 100 μ in diameter and 40 μ high. The 'tail' is 260 μ long by 40 μ wide. It will be noted that the tail is flat and somewhat undulating in comparison with the straight rod-like tail of the T_2 coliphage. *B. megatherium* is one of the larger bacteria susceptible to phage action, and its No. 1 phage probably one of the largest bacteriophages.

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Aug. 16.

[1] Luria, S. E., Delbrück, M., and Anderson, T. F., *J. Bact.*, **46**, 57 (1943).
[2] Baylor, W. R. B., Severns, J. W., and Clark, G. L., *J. Bact.*, **47**, 277 (1944).
[3] Hofer, A. W., *J. Bact.*, **53**, 781 (1947).
[4] Cowles, P. B., *J. Bact.*, **20**, 15 (1930).
[5] Cowles, P. B., *J. Bact.*, **22**, 119 (1931).

Two New Antarctic Leeches

I should like to give here a short preliminary note upon two new antarctic fish leeches. A paper on them has been prepared, but as printing conditions in Norway at present are very difficult, rather a long time may pass before it will be published.

Trulliobdella capitis n. g. n. sp. was collected from *Parachœnichtys georgianus* (Fischer) and *Chœnocephalus bouvetensis* Nybelin. A paper on the latter fish is in the press. The leeches were located to the dorsal part of the fishes' heads, between the eyes. The parasite is dorso-ventrally flattened, showing two body regions, a shorter and more slender præclitellar part, and a postclitellar part which is twice as long and broad. Eyes are present on the oral sucker as well as on the most anterior annuli. The normal somite possesses three primary and six secondary annuli. The mouth opening of the cup-shaped oral sucker is subterminal; the stomach is without posteriorly directed gastric cæca. A 'fold organ' is inserted between the intestine and the rectum. Somital vascular lacunæ are found outside the dermal musculature. The length of the animal is 10–39 mm. As the present species cannot be grouped within any hitherto known genus, a new genus had to be established. Its nearest relatives seem to be the genera *Pterobdella*, *Pterobdellina* and *Phyllobdella*, as these genera are characterized by the absence of posteriorly directed gastric cæca. On the other hand, it seems related to the genus *Branchellion*, because both genera show a 'fold organ' between the intestine and the rectum.

Cryobdellina bacilliformis n. g. n. sp. was collected from the oral cavity of *Parachœnichtys georgianus* (Fischer). There can be no doubt that this leech is closely related to the genus *Cryobdella* Harding, 1922. Common characteristics to both genera are the presence of four testes sacs, the arrangement of posteriorly directed cæca, the diminutive size and the antarctic distribution. As the present species, however, possesses eyes, both on the oral and posterior sucker as well as on the most anterior annuli, and four distinct lateral intestinal pouches, it cannot be assigned to the genus mentioned, and a new provisional genus had to be established. A further characteristic of the animal is the central position of the mouth in the bell-shaped oral sucker, the latter being heptagonal in outline because of dorso-marginal short broad papillæ. Only two specimens were at my disposal, and both seem not to be fully mature, as questionable signs of ovisacs only could be traced. Four pairs of testes sacs were, however, present. The length of the animal was 7–8 mm.

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Wild and Cultivated Rice

The systematics of rice is, as systematists will agree, a matter of more than academic or departmental interest. The improvement of this important cereal depends on its sound classification. To this end the remarks of Dr. D. Chatterjee[1] seem to fall short of what is needed.

One part of Dr. Chatterjee's article consists of unacknowledged verbatim extracts from the first two chapters of a popular essay written twenty years ago by the late Harold Peake[2]. The passages on the

"three successive stages of civilization", "hunting in packs", and so on, might have been taken from Horace or Lucretius. And the transcribed account of "recent discoveries in India", although more up to date, is no longer appropriate to Mohenjo-daro.

The work of Vavilov published in 1926 is referred to by Dr. Chatterjee. Here the disadvantage of relying on what Peake wrote in 1928 becomes serious. It is not the most recent of Vavilov's works, nor does it deal with rice as his later work does. Dr. Chatterjee might, however, have noticed one point in this early paper of great significance: Vavilov's account of *Triticum* establishes the principle in systematics (already well understood in genetics at that time) that chromosome numbers, where they vary, must be a basic criterion in the classification of plants.

Not since 1918 has anyone attempted to discuss the species of wheat without reference to their chromosome numbers. It is due to this fact that the classification of *Triticum* is now so well agreed and its application to breeding, to problems of fertility and sterility, and of hybridization and selection, so fruitfully practised.

Now, since 1936, the species of rice, like those of wheat, have been known to fall into inter-sterile groups defined by their chromosome numbers. Our knowledge of the genus is still fragmentary, but the following points seem to emerge. There are two groups of species, diploid and tetraploid. Each of them contributes types cultivated both for grain and for fodder; and the tetraploid group extends from East Africa, where Dr. Chatterjee has omitted to map *Oryza eichingeri*, to the Philippine Islands, where the grain rice *O. minuta* is cultivated[3].

To these matters Dr. Chatterjee makes no reference. Yet, whether for estimating ancestry, or raising posterity, or even for the more recondite tasks of comparing spikelets and discovering synonymy, it is important to know whether the plant one is dealing with is *O. eichingeri* with 48, as opposed to *O. eichingeri* with 24, chromosomes. It is more important even than to know whether one is dealing with *O. eichingeri* Peter, as opposed to *O. eichingeri* Paul!

What we need to know now, in rice as in many other groups, is whether the herbarium names in fact belong to the living plants which have been found to have particular chromosome numbers. When Dr. Chatterjee has procured these "much-needed data" we may be able to apply his botanical observations to some useful purpose.

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Aug. 21.

[1] Chatterjee, D., *Nature*, **160**, 234 (1947).
[2] Peake, H. J., "The Origins of Agriculture" (Benn's Sixpenny Library, London, 1928), 10, 11, 27, 28.
[3] Darlington, C. D., and Janaki Ammal, E. K., "Chromosome Atlas of Cultivated Plants" (London: Allen and Unwin, 1945).

My article on the wild and cultivated rices was originally prepared at the request of the Economic Botanist, Assam, who is contemplating writing a popular book on rice. Owing to the special nature of my assignment, and also due to my limited knowledge of cytogenetics, I had to restrict myself to the morphology of the rice spikelet and preparation of a key to the species and their enumeration and synonymy. This was stated in the beginning of my article. The published summary in *Nature* essentially deals with this part of my effort, and the omission of cytological discussions and the chromosome numbers of the species of *Oryza* was intentional. This aspect of the subject is being dealt with by my friend in Assam, from other sources. As such, my article, for obvious reasons, was meant to deal only with a particular portion of the problem and should be judged on its own merits. I agree with Dr. Darlington that the chromosome numbers, wherever available, should be given. This enables us to have a better idea of a species and its affinities with other allied species and genera. But whether the chromosome numbers should be all-important and should form the basis of classification in plants is a subject open to controversy between the cytologists and the taxonomists. As a taxonomist, I believe that a natural system of classification of plants based on synthetic methods over a long period has fairly, and within reasonable limits, stood the test of cytologists.

Vavilov's essays on the origin of cultivated plants and Peake's book on the origin of agriculture were of general interest and were freely consulted. A small portion from the latter book was used in a modified form, and in an effort to avoid a large number of inverted commas in a connected text of few lines it was thought fit to acknowledge the book at the end. This has been duly done in the second list of reference books given in my article.

The omission to plot *Oryza eichingeri* in East Africa in the map is very much regretted. This was accidental and I am grateful to Dr. Darlington for directing attention to it. This will be corrected in the fuller paper.

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Aug. 26.

Maturation of Megaloblasts in Bone Marrow Cultures

Investigating the effect of folic acid upon the maturation of megaloblasts, we used a modified bone-marrow culture method of Osgood. During our experiments we saw megaloblasts ripen not only in media containing folic acid, but also in those which contained only the prescribed Osgood medium (65 per cent Gey solution and 35 per cent serum obtained from placental vein). Supposing that the placental serum might contain certain substances responsible for cell growth, in the next stage of our experiment we used normal adult serum instead of the placental one. To our surprise we found that megaloblasts ripen even in these conditions. (At the beginning, the megaloblast ratio of all nucleated red blood corpuscles was 50 per cent, 48 hours later only 8 per cent.) In the third stage of our experiments we further modified Osgood's method and used sera obtained from patients suffering from pernicious anæmia. We had every reason to suppose that normal serum might contain the anti-anæmic factor, which is absent in pernicious anæmia sera. Hence, we put the bone marrow simultaneously into vessels containing normal, and others containing pernicious anæmia sera, both prepared under the same conditions as above. The surprising result was that megaloblasts ripened in the pernicious anæmia medium too, although to a lesser extent. (Example: decrease of the relative number of the megaloblasts in 48 hours from 50 to 18 per cent.)

We suspected—rather boldly—that the megaloblasts in the media containing pernicious anæmia serum ripen less perhaps because there is an inhibitory factor which is diluted by the Gey solution. In the next experiment we changed the proportions, using as medium 65 per cent pernicious anæmia serum and only 35 per cent Gey solution. The result was that no ripening of megaloblasts took place (37·5 per cent at the beginning and 36·5 per cent after 48 hours). Our supposition seemed to be justified, so in the next experiments we made the following parallel cultures: 35 per cent normal serum and 65 per cent Gey solution; 65 per cent normal serum and 35 per cent Gey solution; 35 per cent pernicious anæmia serum and 65 per cent Gey solution; 65 per cent pernicious anæmia serum and 35 per cent Gey solution. Every experiment had a double control and in each case we used the same marrow for the different media. The results were: megaloblasts ripened better in concentrated than in diluted normal sera, but much less (or not at all) in concentrated than in diluted pernicious anæmia ones.

We conclude, therefore, that: (1) folic acid acts directly upon the megaloblasts; (2) pernicious anæmia serum seems to contain an inhibitory substance exerting its effect upon the ripening of the megaloblasts. Its degree of action depends upon the concentration or dilution of the pernicious anæmia serum in the marrow cultures.

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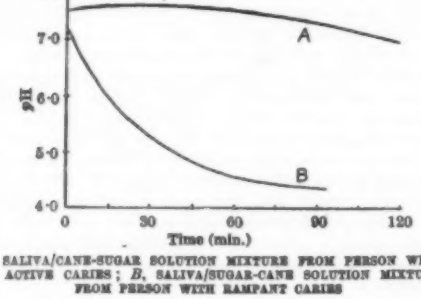
Acid Production in Saliva/Cane-sugar Solutions

Two factors are of paramount importance for starting a carious lesion (erosion) in the enamel of human teeth: (1) the rate of acid production in mixtures of carbohydrates with saliva in retention areas on teeth; and (2) the speed with which the acid formed and the acid-producing carbohydrates are removed from these areas.

We have studied the acid production in saliva/cane-sugar solutions from caries-susceptible persons and from persons with no active caries. The mixtures were held in a thermostat at 37° C. and the *p*H measured electrometrically. The velocity of acid formation varied within wide limits. It was observed that a drop of *p*H to a point at which decalcification of enamel presumably starts in extreme cases may take place within a few minutes (see graph).

To study the rate of removal of soluble acids formed in the retention areas we used pellets of filter paper, dyed in a water-soluble dye, pressed in between the approximal surfaces of teeth. We have found that after two hours without any food or drink intake, more than 50 per cent of the dye was washed out.



A, SALIVA/CANE-SUGAR SOLUTION MIXTURE FROM PERSON WITH NO ACTIVE CARIES; *B*, SALIVA/SUGAR-CANE SOLUTION MIXTURE FROM PERSON WITH RAMPANT CARIES

After centrifuging salivas or filtering through ordinary paper filters, the centrifugates were found inactive. The precipitates, however, gave when mixed with cane-sugar solutions a surprisingly rapid acid formation.

On the basis of these observations, it is evident that the elements in saliva capable of producing acid rapidly after incubation with cane-sugar solution are concentrated in the precipitating masses (mucin, epithelial cells, leucocytes, micro-organisms, etc.). The rate of acid production is so rapid that we doubt very much whether this process is caused, as hitherto suggested, by the activity of micro-organisms; we believe it is probably due to an enzyme system already present in saliva.

In persons with slow acid production in saliva/cane-sugar solutions, we have at times of intermittent illness found the rate of acid formation greatly accelerated; in such cases 'normal' values are reached fairly rapidly during convalescence.

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Oslo. Oct. 2.

Effects of Anterior Pituitary Extract and Hypophysectomy on Blood-Sugar Levels after Injection of Alloxan

Kirschbaum, Wells and Molander[1] find that alloxan hyperglycæmia does not occur but is replaced by fatal hypoglycæmia in fasting rats from which the pituitary gland had been removed, either immediately before, or 72 hours before, injection of alloxan. Houssay, Orías and Sara[2], using recently hypophysectomized toads, say that alloxan hyperglycæmia is not abolished by hypophysectomy. Martínez and Orías[3] find that injection of alloxan induces some degree of hypoglycæmia in normal rats and in rats hypophysectomized six days previously. Normal blood-sugar levels in both cases were regained 48 hours after injection.

Experiments in this laboratory show the disagreement in the literature is due to: (*a*) different periods of time elapsing between operation and injection of alloxan; (*b*) failure to take into account the glycostatic function of the anterior pituitary gland; (*c*) insufficient number of, or no, control operations.

This latter criticism also applies to experiments of Kirschbaum *et al.*, and Goldner and Gomori[4] on adrenalectomy and effect of alloxan, and may explain the disagreement between their results and those of Houssay *et al.*

The animals used in the present work were inbred hooded rats weighing between 100 and 150 gm. and wild rabbits obtained as 200–300 gm. kittens and raised in the laboratory. Hypophysectomy was carried out on rats under 'Avertin' anæsthesia. Control operations consisted of the same procedure, except that drilling ceased before the pituitary was reached (sham-operated). Completeness of removal of the pituitary was checked at autopsy in all cases, and the results from incompletely hypophysectomized animals rejected. Rats were fasted 24 hours before injection of alloxan, and rabbits 17 hours. Under these conditions it was found that intraperitoneal

injection of 200 mgm./kgm. of alloxan brought about no change in blood-sugar level of the intact hooded rat 4 hours after injection. On rats sham-operated 24 hours previously, blood-sugar values ranging from marked hypoglycæmia (43 mgm. per cent) to marked hyperglycæmia (352 mgm. per cent) were found four hours after injection of alloxan. Rats hypophysectomized 24 hours previously were consistently hypoglycæmic (average value of 49 mgm. per cent) four hours after injection. However, it is difficult to see on what statistically permissible grounds the figures for the sham-operated group can be averaged and the figure compared with the mean figure for the hypophysectomized group. It would appear that some factor other than hypophysectomy alone is involved in the hypoglycæmia of the hypophysectomized group. These results indicate that, in rats, operations carried out a short period before commencement of the experiment cause unpredictable changes in blood-sugar level after alloxan, which invalidate the experiment.

If, however, the rats were allowed to recover from the operation for a period of eight days, those subjected to the sham operation were normal in that they showed no blood-sugar change four hours after intraperitoneal injection of 200 mgm./kgm. of alloxan. These had apparently recovered from the effect of the operation and behaved like intact rats injected with alloxan. Those rats subjected to the operation of hypophysectomy eight days previously, whether receiving alloxan or control injections of water, showed to a similar degree the well-known spontaneous hypoglycæmia of fasting hypophysectomized animals (average of 63 mgm. per cent for the alloxan group and average of 47 mgm. per cent for group receiving water). This spontaneous hypoglycæmia is due to lack of the glycostatic action of the anterior pituitary.

The effect on blood-sugar levels after injection of alloxan of the opposite procedure to hypophysectomy, namely, pretreatment by parenteral injection of anterior pituitary extract, was studied in rabbits. The extract used was an alkaline extract of fresh ox anterior lobes made according to the method of Young[5]. Pretreatment consisted of three subcutaneous injections of the extract at 24, 17 and 3 hours before injection of alloxan. Total pretreatment dose was equivalent to 5 gm. fresh anterior lobes. The results fell into two groups according to the weight of the animals. In rabbits weighing 800 gm. or more, pretreatment with anterior pituitary extract resulted in a much greater hyperglycæmia (average figure of 160 mgm. per cent at two hours after intravenous injection of 200 mgm./kgm. of alloxan) than in rabbits not pretreated (average figure of 110 mgm. per cent at two hours). The onset of hypoglycæmia was delayed in the pretreated rabbits. Using the T test, the difference between the average curve for the pretreated rabbits and that for the untreated rabbits was significant ($P > 0{\cdot}05$).

In rabbits weighing 500 gm. or less, slight hyperglycæmia appeared in the pituitary pretreated animals after intravenous injection of 200 mgm./kgm. of alloxan. This hyperglycæmia (average figure of 113 mgm. per cent at two hours) was then followed by marked hypoglycæmia, but in the untreated controls only hypoglycæmia (average figure of 67 mgm. per cent at two hours) without preliminary hyperglycæmia appeared. The difference between the average curve for the pretreated rabbits and that for the untreated rabbits was significant ($P > 0{\cdot}02$), as was the difference between the average response for untreated 800 gm. rabbits and untreated 500 gm. rabbits ($P > 0{\cdot}01$).

Further work is in progress on this enhancement of alloxan hyperglycæmia, and a detailed report will be published at a later date.

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Canberra. Oct. 4.

[1] Kirschbaum, Wells and Molander, *Proc. Soc. Exp. Biol. and Med.*, **58**, 294 (1945).
[2] Houssay, Orías and Sara, *Science*, **102**, 196 (1945).
[3] Martínez and Orías, *Rev. Soc. Argent. Biol.*, **21**, 290 (1945).
[4] Goldner and Gomori, *Endocrin.*, **35**, 241 (1944).
[5] Young, *Biochem. J.*, **32**, 513 (1938).

Sound Emitted by Dolphins

WITH reference to Dr. Kullenberg's observation in *Nature* of November 8, p. 648, on sounds emitted by dolphins, the following quotation from Capt. Parry's "Journal of a Voyage for the Discovery of the North West Passage", 1821, is relevant. It concerns the white whale (*Delphinapterus leucas*), p. 35. "Mr. Fisher described them to be generally from 18–20 feet in length; and he stated, that he had several times heard them emit a shrill, ringing sound, not unlike that of musical glasses when badly played. This sound, he further observed, was most distinctly heard, when they happened to swim directly beneath the boat, even when they were several feet under water, and ceased altogether on their coming to the surface."

In *Natural History*, January 1940, p. 19, there is an account of observations on dolphins kept in captivity at the Marine Studios, Florida. The writer, Arthur F. McBride, gives a description of the sounds emitted by dolphins while under water and their use as a means of communication.

During the voyage of the Danish *Atlantide* Expedition to West Africa, 1945–46, dolphins were heard to make noises under water on several occasions. These were described to me by Dr. A. F. Bruun of the University Zoological Museum, Copenhagen, as being high-pitched whistles. The sound was outside the upper limit of my range of hearing.

That dolphins are sensitive to high-pitched notes is supported by another observation made while I was in the *Atlantide*. On December 30, 1945, a school of about a hundred *Delphinus delphis* was near the ship in calm water, splashing, diving and leaping vertically out of the water. The dolphins suddenly dashed away at great speed and their disappearance coincided with the switching on of the ship's supersonic echo-sounding machine. This sensitiveness to supersonic emissions was confirmed on a later occasion.

Dr. M. Burton of this Museum and I, in company with Major H. W. Hall, the owner of the yacht *Manihine*, watched common dolphins for a few minutes under ideal conditions this summer in the eastern English Channel. The dolphins could be clearly seen swimming under water and we observed that, intermittently, a stream of fine bubbles issued from the blowholes of the animals while they were still submerged to a depth of a fathom or two. None of us heard any emission of sound, but the possibility is suggested that it may be connected with this phenomenon.

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PHYSIOLOGICAL EFFECTS OF ALKYL POLYPHOSPHATES

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DURING the War, the Germans introduced as insecticides a series of phosphate esters, including tetraethylpyrophosphate and hexaethyltetraphosphate. From information supplied to us by Mr. B. Topley, it appears probable that both these materials, in the form in which we have used them, were, in fact, mixtures of substances with the empirical composition implied by their names; in any event, it is certain that hexaethyltetraphosphate is almost instantaneously largely hydrolysed in water into simpler bodies. In toxicity tests[1,2] a characteristic syndrome of hyperexcitability, twitching, salivation and convulsions, has been noted with doses of 1–3 mgm./kgm. Dubois and Mangun[2,3] showed that these compounds are potent anticholinesterases; they are more active than diisopropylfluorophosphonate in the rat both *in vitro* and *in vivo*; this finding has been confirmed on the American roach[4].

We have examined the action of hexaethyltetraphosphate and tetraethylpyrophosphate on isolated organs in a number of species and on various systems in cats.

Action on the isolated tissues. The effects of hexaethyltetraphosphate were studied on the frog rectus abdominis muscle, the perfused rabbit heart and the rabbit and guinea pig small gut. With small doses no direct action was observed; but a progressive sensitization of the organ to acetylcholine occurred until only 1/10–1/100 of the dose of acetylcholine previously required to produce a given response was effective. The effect of this smaller dose of acetylcholine was nearly always prolonged; that is, cardiac slowing or arrest persisted for much longer periods and the gut relaxed more slowly on washing. A detectable effect first appeared with concentrations of hexaethyltetraphosphate of 10^{-8}–10^{-7} (2×10^{-8}–2×10^{-7} *M.*) and reached a peak at 10^{-6}–10^{-5} (2×10^{-6}–2×10^{-5} *M.*). The potentiation produced by hexaethyltetraphosphate persisted for at least six hours despite repeated washing out; indeed, this potentiation was always greatest after washing out the hexaethyltetraphosphate several times. In concentrations of 10^{-4}–10^{-3} *M.*, hexaethyltetraphosphate produced direct effects on the test organs. The guinea pig gut and frog rectus progressively contracted; the rabbit's heart slowed and decreased in force; the rhythmic contractions of the rabbit intestine increased in amplitude, and the resting tone rose. The rise in tone was initially annulled by atropine, but later the tone continued to rise despite atropine. Hexaethyltetraphosphate produced maximum potentiation of acetylcholine action in concentrations two hundred times smaller than is the case for diisopropylfluorophosphonate. Tetraethylpyrophosphate produced similar qualitative effects to hexaethyltetraphosphate; its action was greater but more transient; thus on the guinea pig gut some recovery was noted in 1 hr. Triethylorthophosphate in 100–1,000 times the concentration of hexaethyltetraphosphate produced a marked depression of the rabbit heart, and a small potentiation of the action of acetylcholine on the other organs (equivalent on the guinea pig ileum to 1/400 of that of hexaethyltetraphosphate).

Action of hexaethyltetraphosphate in the chloralosed cat. The toxicity syndrome on intravenous injection of hexaethyltetraphosphate in increasing doses was as follows:

0·025–0·1 mgm./kgm.: no detectable effect.

0·2–0·3 mgm./kgm.: slight bradycardia and slight fall of blood pressure.

0·4–0·6 mgm./kgm.: marked slowing of the heart (to half the initial rate) and fall of blood pressure (of 60–100 mm. mercury), which began to recover after 10–20 min. Respiration was stimulated; marked salivary and bronchial secretion, micturition and excessive bowel movements with defæcation occurred. The pupils were usually dilated, but the nictitating membrane was not retracted; sometimes pupillary constriction occurred. Muscle fasciculation and minor convulsive movements were seen and the animal responded markedly to jarring.

0·8–2·0 mgm./kgm.: almost immediate violent convulsions; very marked slowing of the heart and fall of blood pressure (to about 40 mm. mercury); profuse salivary and bronchial secretion, vigorous gut movements and defæcation. The animal's condition rapidly deteriorated and death usually occurred in less than one hour.

After atropinization most of the visceral effects were abolished and doses up to 100 mgm./kgm. were given intravenously without producing serious visceral or respiratory changes.

Tetraethylpyrophosphate produced similar effects in comparable doses; triethylorthophosphate produced no systemic effects.

Action of hexaethyltetraphosphate on response to peripheral stimulation of vagus (cat). In control experiments supramaximal stimulation at 1, 2, 4, 10, 25, 50/sec. produced graded slowing of the heart and fall of blood pressure. After giving hexaethyltetraphosphate the maximum immediate effect of a given stimulus was only increased by 10–40 per cent, but the recovery period was much prolonged. On stimulating at 10/sec. for 5 sec. the area under the blood-pressure and heart-rate recovery curves was doubled by 0·2 mgm./kgm., quadrupled by 0·4 mgm./kgm. and increased 10–20 times by 0·8 mgm./kgm. These effects lasted for at least 6 hr. 0·4 mgm./kgm. of hexaethyltetraphosphate caused a 2–4 fold potentiation of the bradycardia produced by intravenous acetylcholine. After 2 mgm./kgm. of hexaethyltetraphosphate the animal became completely unresponsive to vagal stimulation; whereas 0·1 μgm. of acetylcholine had previously produced a marked fall in blood pressure, no response was obtained until 2 mgm. of acetylcholine was injected, when a small rise of blood pressure occurred.

Effect of salivary secretion. A marked flow of saliva occurred on injection of 0·4 mgm./kgm. of tetraethylpyrophosphate even after the chorda tympani had been cut; during this time no increase in salivary flow occurred on stimulating the peripheral end of the nerve; when this spontaneous flow ceased the response to nerve stimulation returned to its previous magnitude.

Effect on nictitating membrane. The response of the nictitating membrane to peripheral stimulation of

the cervical sympathetic trunk was unchanged until 1 mgm./kgm. of hexaethyltetraphosphate was injected, when some potentiation occurred.

Conjunctival application of 1 drop of 1 per cent hexaethyltetraphosphate solution constricted the pupil.

Effect of intravenous hexaethyltetraphosphate on the nerve muscle response in chloralosed atropinized cats. The popliteal nerve was stimulated with maximal shocks from a thyratron and coil once every 2·5 sec.; the response of the gastrocnemius-soleus muscle was recorded (*a*) mechanically by a torsion lever on a smoked drum, and (*b*) electrically from belly-tendon leads. Doses of hexaethyltetraphosphate smaller than 0·2–0·3 mgm./kgm. had no apparent effect. Further doses of the order of 0·5 mgm./kgm. had a marked potentiating action on the nerve muscle response. The mechanical response increased by 40–80 per cent, was maintained for some minutes slightly below peak level, and than gradually returned to normal. Action potentials showed no increase in amplitude but a repetitive response developed, consisting of one or two additional synchronous discharges, followed by an asynchronous discharge of smaller amplitude which persisted for about 100 m.sec. The control synchronous action potentials had a duration of 10 m.sec. The nerve muscle potentiating doses of hexaethyltetraphosphate had very little effect on blood pressure and produced only slight fasciculation. Further increase in the dose of hexaethyltetraphosphate produced additional potentiation followed by depression of the nerve muscle response; as the dose was still further increased, the initial potentiation became less and the subsequent depression more profound. Doses of hexaethyltetraphosphate of the order of 2 mgm./kgm. were purely depressant. Doses (0·5 mgm./kgm.) which potentiated the response of the nerve muscle preparation reversed a 90 per cent depression of the nerve muscle response caused by a previous appropriate dose of a curare preparation ('Intocostrin'). Essentially similar effects on the nerve muscle responses were produced by tetraethylpyrophosphate.

Action of hexaethyltetraphosphate on spinal reflexes. This was studied in decerebrate and chloralosed cats with and without atropine. The reflexes examined, namely, knee-jerk, flexor reflex and crossed extensor reflex, were generally initially potentiated; these changes were accompanied by variable degrees of fasciculation of peripheral origin. Increase of resting extensor tone and convulsions, sometimes violent and prolonged, were noted. A small increase in the dose of hexaethyltetraphosphate frequently converted increased reflex responses into depression. The effect of the drug was sometimes different on different reflexes; thus depression of the knee-jerk might coincide with potentiation of the flexor reflex. Convulsions have also been produced by tetraethylpyrophosphate; these were usually mild and transitory, but muscle fasciculation was very marked.

Intrathecal injection of hexaethyltetraphosphate produced with increasing doses an increased 'repetitive' knee-jerk (0·05 mgm./kgm.), increased crossed extensor reflex (0·4 mgm./kgm.), mild convulsions (0·6 mgm./kgm.) and increased resting extensor tone followed by very violent convulsions (4 mgm./kgm.). The initial phenomena were unaccompanied by any change in blood pressure or in the nerve muscle response. The very violent convulsions produced by the larger doses of hexaethyltetraphosphate were, however, at their peak, associated with an increase in the nerve muscle response, suggesting slight absorption of the drug into the general circulation. The hexaethyltetraphosphate convulsions were phasic, and sometimes a second burst of convulsions occurred when the nerve muscle response had returned to its control condition. The evidence indicates that hexaethyltetraphosphate (like diisopropylfluorophosphonate[5] and the tertiary anticholinesterases[6]) has a central excitant action on the spinal cord.

We are indebted to Mr. B. Topley for chemical information and to Messrs. Pal Chemicals for supplies of materials.

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ETIOLOGY OF STRAWBERRY VIRUS DISEASES

By Dr. CONWAY A. WOOD and Dr. T. WHITEHEAD

STRAWBERRY virus diseases in Great Britain have hitherto been described mainly on the basis of the symptoms shown by the 'sensitive' variety Royal Sovereign[1,2], and are classified under the terms 'crinkle' and 'yellow-edge', each of which includes a wide range of symptom-intensity. It is now recognized that certain of the so-called 'tolerant' varieties, such as Huxley and Oberschlesien, also suffer degeneration due to virus infection, exhibiting symptoms which may resemble closely those of yellow-edge in Royal Sovereign[3,4]. The wild strawberry, *Fragaria vesca* L., owing mainly to its marked virus sensitivity, has been much employed as an indicator plant in the study of these diseases.

In investigations during the period 1938–45, we concentrated at first on an analysis of the virus entity causing 'severe crinkle' in Royal Sovereign, the complex nature of which had been suggested by earlier workers[5,6]. Efforts to segregate component viruses by (i) the use of possible differential insect vectors, (ii) comparison of aphis-transmission with graft-transmission, and (iii) the use of possible differential host plants were all unsuccessful, but a separation of 'non-persistent' and 'persistent' virus components was at length accomplished by daily transfers of infective aphides (*Pentatrichopus* (*Capitophorus*) *fragariæ* Theob.) along series of *F. vesca* indicators. Distinct symptomatological differences appeared between the first plants—that is, those colonized directly from the infector-plants on the first day of the experiment—and all subsequent plants. Both components were later retransmitted from *F. vesca* to other *F. vesca* plants, and to Royal Sovereign, both by graft- and aphis-transmissions. Evidence was obtained that separation of the components is not affected either by post-infection starvation of the vectors or by a sojourn of the latter on the virus-immune plant *Potentilla anserina* L.[4] between infection-feeding and feeding on the indicator plant, but is dependent solely upon lapse of time between these two feedings.

The results led us to the conclusion that plants of Royal Sovereign suffering from severe crinkle contain

two viruses, one of which persists in the aphis vector for several days and the other for not more than one day. These results, however, were obtained only by the use of aphides which were reared on the Royal Sovereign infector plants. When similar experiments were conducted with aphides given only short infection-feeds (up to 4 hr.) the aphides remained infective only for a short time, and symptoms of the non-persistent virus type alone were produced in *F. vesca*. The persistent component either was not transmitted, or was retained in the aphides for no longer than was the non-persistent component. This agrees with the results of contemporaneous experiments at East Malling[7], in which aphides fed for short periods (up to 24 hr.) on certain infector plants, including 'severe crinkle' Royal Sovereign, transmitted only a non-persistent virus.

A beginning was later made in the analysis of other diseases met with in the field. It was found that 'mild crinkle' in Royal Sovereign most probably contains only a non-persistent virus, whereas both non-persistent and persistent viruses were obtained from Royal Sovereign affected with yellow-edge; from 'degenerate' Huxley showing yellow-edge-like symptoms; and even from a normal, vigorous, clonal stock of Huxley ('Malling 44'). It is considered that the virus components of yellow-edge in Royal Sovereign and of 'degenerate' Huxley are of similar type and are perhaps identical. The viruses in normal, vigorous Huxley (M44) and in a Royal Sovereign stock (M35) showing mild crinkle are also of similar type, but are probably not identical since only the former has given definite evidence of a persistent component. The persistent viruses isolated from 'degenerate' Huxley, from vigorous Huxley and from yellow-edge in Royal Sovereign, all appear to differ from the persistent virus in Royal Sovereign plants showing severe crinkle.

These tentative groupings were supported by the results of a later experiment with the variety Huxley. Degeneration was produced in plants of the M44 clone of this variety by colonizing them with aphides (*P. fragariæ*) reared on Royal Sovereign showing yellow-edge or on 'degenerate' Huxley or Oberschlesien plants (both showing symptoms resembling yellow-edge). Degeneration did not occur, however, where the aphides used had fed on Royal Sovereign showing mild or severe crinkle or on vigorous plants of Huxley or Oberschlesien. We at no time obtained evidence that the two latter varieties can carry, without symptoms, viruses capable of causing yellow-edge in Royal Sovereign.

In the course of these studies the symptoms of crinkle in Royal Sovereign and in *F. vesca* were analysed into 'unit characters', comprising reduction in size, distortion, leaf malformation, chlorosis and pigmentation, the varying proportions of which give rise to the wide range of symptoms shown by infected Royal Sovereign plants in the field. An appreciable variability in the clinical picture also occurs among plants of either *Fragaria vesca* or *F. moschata* Duch.—even though clonal—when these are infected with either mild or severe crinkle under conditions made as uniform as possible. Many carefully investigated examples led us to the opinion that symptom variability, especially in *F. vesca* but also in Royal Sovereign, is a function not only of virus content but also of the individuality of the plant in its reaction to a given virus, and that this is a factor to be taken into account both in fundamental research and in field surveys.

This work, a full account of which will be published later, was carried out at the School of Agriculture, University College of North Wales, Bangor, with the aid of a grant from the Agricultural Research Council.

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PROGRESS IN ELECTRON MICROSCOPY

MORE than a hundred and fifty people, including visitors from the United States, Holland and France, attended the conference of the Electron Microscopy Group of the Institute of Physics which was held during September 16–17 at the University of Leeds. The meeting opened with addresses of welcome from the Vice-Chancellor of the University and from Prof. R. Whiddington; Sir Charles Darwin was in the chair.

The first session was devoted mainly to biological topics. Drs. R. Reed and K. M. Rudall (Department of Biomolecular Structure, Leeds), in a paper illustrated by many slides and enlarged micrograms, described work on gold-shadowed replicas of (*a*) the non-banded collagen-type fibres of the earthworm cuticle, and (*b*) the cell structure of striated muscle fibres from the frog. In the former case valuable information is provided on the manner of growth of the fibres and how they are arranged in layers of alternating fibre direction; while in the latter further details showing the organisation of the sarcolemma, sarcoplasm and striated myofibrils are clearly revealed. Investigations such as these, the results of which are now being reported from many countries, make it evident that the time is rapidly approaching when a new histology will have to be written.

Dr. V. E. Cosslett (Cavendish Laboratory) and his colleagues dealt with the preparation of bacteria for electron microscopic examination. Many cells are too opaque to show internal detail when using the 60 kV. beams of most present-day microscopes, but methods had been developed for rendering them more transparent, for example, by treatment with acetic acid vapour, ether vapour, or hydrochloric acid. Internal structures have also been revealed by light metal-shadowing, or by normal evaporation of metals on to the organism, or by the use of very thin supporting films of beryllium. Details of the preparation and handling of such films were given and photographs showed their obvious value in this type of study. Dr. N. E. Brieger (Papworth, Cambridge) further illustrated the methods by reference to the growth of avian tubercular bacilli on a solid medium. Dr. F. M. L. Sheffield (Rothamsted Experimental Station) described how certain plant viruses produce abnormal inclusion bodies in the cells of the host. By micrurgical methods some of these bodies have been isolated and examined in the electron microscope and their contents compared with other parts of healthy and infected cells. In cells infected with tobacco mosaic virus, the virus particles are located not only in the cell nuclei, but in other parts of the cell besides. In severe etch disease, an examina-

tion of nuclear and cytoplasmic inclusions revealed crystalline bodies, many of which show details of internal structure. In a paper by Dr. L. Dmochowski and Prof. R. D. Passey (Department of Experimental Pathology and Cancer Research, Leeds) and Prof. W. T. Astbury and Dr. R. Reed (Department of Biomolecular Structure, Leeds), extracts of normal and malignant tissues derived from mice of high and low breast-cancer strains were studied. Roughly spherical particles of about 200 A. diameter were found in the extracts of lactating breast tissues and of breast tumour tissues obtained from mice of three high-cancer strains. Extracts of lactating breast tissues and of experimentally induced breast tumours from mice of two low-cancer strains were found to be free of these particles. All extracts are being examined for tumour-inducing activity in susceptible mice, and the results of these tests are keenly awaited. [See also *Nature*, October 25, p. 565.] Dr. van Dorsten (Philips, Eindhoven) illustrated the possibilities in the use of high-velocity beams by showing photographs of yeast cells taken with electrons ranging from 70 to 300 kV. At the higher voltages there was surprisingly little loss of contrast, and internal detail was clearly seen.

The remainder of the session was devoted to problems of technique. Dr. A. E. J. Vickers (Imperial Chemical Industries, Ltd., Billingham) referred to various devices for simplifying the manipulation of grids covered with thin supporting films. The photographic methods employed at Billingham were mentioned; since the electron beam often adversely affects the specimen, photography after a fixed time interval is recommended to obtain comparable micrograms. Mr. M. E. Haine (now of A.E.I. Research Laboratories, Aldermaston) gave an account of the new Metrovick experimental microscope. The new model employs a three-lens system which allows a wide control of magnification (1,000–50,000 times at 50 kV.) with a great reduction in the size of the instrument. The pumping-out time from atmospheric pressure, even with the small diffusion pump used, is only about 2½ minutes. No air-locks are necessary, and a precision-made specimen stage of a robust design is thereby made possible. Improved electron gun performance gives usable image brightness even at the highest magnifications: at present the instrument operates at 50 kV., but higher voltages are allowed for in the design. The instrument was demonstrated at the Conference and was enthusiastically examined by a large number of visitors. A paper on asymmetry in electrostatic lenses and its correction was read by Prof. P. Grivet (TSF Laboratory, Paris). A theoretical treatment showed that lens asymmetry is due mostly to mechanical defects, and mention was made of a correcting device consisting of four solenoids spaced 90° apart which could be rotated about the axis of the lens. In discussion it was agreed that such a device would be successful, but doubt was expressed whether it would be easily workable. Dr. Bruck, of the same Laboratory, reported on a simplified form of microscope for the study of cathodic emission. The object surface (about 3 mm. in diameter) was easily changeable and could be heated to 2,500° C. by electron bombardment. Magnifications from 50 to 2,000 were provided by a two-stage electrostatic lens system, and preliminary results from various metallic surfaces were presented.

On September 17, Prof. W. T. Astbury was in the chair, and the time was devoted to problems of specimen examination. Dr. V. E. Cosslett (Cambridge) demonstrated that specimens exposed to the electron beam for some time often show a loss of contrast and considerable visible growth. These effects were especially strong on particles in direct contact with the specimen grids, but less noticeable on material supported on collodion or similar non-conducting films. Studies with different specimens on a variety of grids suggested that the effects arise from a contamination, partly from the specimen grid itself and partly from traces of organic material which are deposited on the specimen and grid. Where particle size is sought, Dr. Cosslett suggested the use of cleaned grids, a clean vacuum and specimens supported on non-conducting films. Photography in the central regions of the grid spaces was also recommended. Mr. I. M. Dawson (National Institute for Medical Research, Hampstead), in a study of the metal-shadowing technique, reported on the degree of gold aggregation occurring on different types of supporting film, as assessed by electron diffraction methods. The crystallite size of gold deposited on graphite films, for example, was found to be much greater than on collodion films. Evidence was given to show that direct shadowing of gold on to a specimen already mounted on a supporting film leads to more aggregation than if the metal is first deposited on the specimen and removed later by a stripping technique. It was considered that light metal-shadowing leads to less artefact production, and support was given for the contention that with metal-shadowed specimens further evaporation and deposition of metal may occur during examination in the microscope.

The Conference ended with a discussion on the most suitable choice of photographic material. Dr. R. Reed and Mr. A. Millard (Leeds) gave the results of testing a number of plates and films. Certain emulsions were mentioned as having ample contrast and reasonable grain size, yet showing a rapid response to electrons. The advantages of such fast emulsions were listed, the chief being that they minimize the risk of image movement during exposure. Particular emphasis was laid on the use of 35-mm. film, since the precision techniques of miniature photography can then be applied. In discussion it emerged that the high sensitivities quoted were in some way connected with small-grained emulsions of a high silver/gelatin ratio. Further tests on various plates and films were reported by Mr. I. M. Dawson, who also described a successful roll-film adaptor for use in the Siemens type of microscope. It was mentioned that when non-conducting materials are used in such electron cameras, attention must be paid to the problem of the dispersal of charge on the recording film.

In conclusion, it is gratifying to report that teething troubles in British electron microscopy are now more or less over, and that, so far as present conditions permit, the outlook is full of promise. Not only have the new techniques been learned; they are being actively applied and developed in the elucidation of many fundamental problems, particularly in the biological field. It may be claimed that the new Electron Microscopy Group of the Institute of Physics is now safely launched, and the growing membership and increasing vigour of its discussions augur well for the future.

More complete accounts of the contributions summarized above will be published elsewhere.

R. Reed

FORESTRY IN BRITISH COLONIAL TERRITORIES

IN the Forest Administration Report for Nigeria (Gov. Printer, Lagos, 1945; London: Crown Agents for the Colonies. 4*s*.) it is stated that in future the forest year will close at the end of March instead of at the end of December, due to the fact that at the end of December most of the forest work carried out in the cold-weather season is only half completed. In India the close of the forest year has always been March 31 for the same early recognized reason. The report in question, therefore, is dated from January 1, 1944, to March 31, 1945. In it we read that yet another revision of the forest policy of the Government was approved in February, 1945. The objects are briefly summed up. Since subsistence farming by a rapidly increasing population is the major industry of the country, the forest policy aims at preserving the climatic and physical condition of the country, its soil fertility and its water supplies by the maintenance and improvement of the vegetation cover, and at supplying in perpetuity and as cheaply as possible all the forest produce both as raw material and as the product of forest industries, required for the well-being of the inhabitants of the country.

Because of the growing demand in Nigeria for land for cultivation, it is essential that the forest estate should be secure, well distributed, and intensively managed, and that exploitation be controlled and improved and forest industries initiated and developed to prevent waste of land or produce. A ten-year plan of development detailing the staff and expenditure required to give full effect to the policy was submitted during the year, and is still under consideration.

Even before the War, but particularly during its preoccupations, inadequate staff has resulted in farming encroachments in reserves; so much so that a certain area of previously reserved forests has now been lost. It is said that as opportunities begin to increase for the necessary stock-taking, it has become depressingly obvious that only a much increased protective staff, firmer deterrents by adequate penalties in the courts and a more rigorous attitude on the part of Government in its reservation policy and practice will check these alarming forest depredations. Among other losses of forest, the Benin Native Administration has had to excise 396 sq. miles which have been so much farmed as to be no longer productive forest. In this connexion a remark is noted by the Conservator of Forests, N.E. Circle, on revisiting the area of the Benin Forest where he had practised sylviculture for some years. "I should like to place on record that I have never seen such extensive forest destruction anywhere to compare with that which has taken place in the unreserved forests of Benin Division during the last ten years. It is indeed fortunate that more than 50% of the forests of the Division have already been reserved. Forest reserves scarcely require to be demarcated now, because they stand out so prominently in the landscape." Other considerable excisions of so-called forest reserves have had to be made in other parts of Nigeria. The report states that: "The reserves, approved many years ago, have in numerous cases not been clearly demarcated and described, and they are steadily being whittled away by the encroachments of farmers. Persistent and continuous efforts to consolidate what remains of the forest, which is essentially the last local source of timber and fuel for a rapidly increasing population, have consistently failed. They will continue to fail if the Department cannot obtain administrative support in resisting the truculent demands of the improvident cultivators. There is admittedly very definite land hunger in this Province, but the relinquishment of all forest land for agriculture will not relieve the pressure for more than a few years, while the production of timber and fuel on land degraded by continuous cultivation and incapable of producing food will then be difficult and expensive."

In the Report for the Forestry Department, Nyasaland, to the end of December, 1945 (Zomba: Gov. Printer, 1946), it stated that the activities of the Department during the year were mainly devoted to maintenance and consolidation of progress already achieved. Proposals for planting schemes in various native areas, mainly for firewood production, were considered by several district development committees, and in most cases endorsed. It is thought that such short-term schemes can usually be financed either by native treasuries or by grants from the local native development and welfare fund. On the other hand, long-term schemes in native areas for the production of major timber will generally require assistance from funds provided under the Colonial Development and Welfare Act, 1945. A pre-requisite, however, for all further forestry development is an increase in the European staff and a local school for training Africans in forestry. An urgent need is to impress on the large African population the principle that payment will have to be made by the people for the ultimate produce derived from forest plantations, and that for the large majority of village communities the only alternative to planting schemes is for them to maintain adequate village forest areas (natural woodland) from which produce may be taken free of charge in return for the free communal labour given in the protection and simple management of the areas.

A committee was set up by Government to make recommendations concerning the legislation which is required to ensure the conservation and improvement of the natural resources of the Protectorate. Recommendations were submitted to Government in the form of a bill introduced at the session of the Legislative Council held in December. The proposed legislation has an important bearing on forest policy, and is greatly welcomed by the Forestry Department.

An interesting item of information of possibly considerable value in the future is contained in the following extract: "Certain areas of the Rift Valley escarpment in Dowa and Dedza district are assuming an increasing importance as a source of bamboos for commercial purposes, the manufacture of tobacco baskets being one of the main items. In order to effect greater control over this trade a bamboo market was established by the Department at Mvera on the Dowa escarpment, and its success was reflected in a great increase in sales of bamboos from the region. It is hoped to set up bamboo markets at other centres. Villagers, of course, come from afar to these escarpments to take bamboos free of charge for their own domestic requirements. Very large numbers of dead bamboos, following a gregarious seeding, are available for cutting in Mua-Livulezi forest reserve near the railway in Dedza district. Local demand is only small and undoubtedly there is scope here for commercial enterprise."

The Administration Report to the end of 1945 of the Conservator of Forests, Trinidad and Tobago (Gov. Printer, Trinidad, 1946), makes interesting reading. In some ways Trinidad has made considerable progress as compared with other forest services under the Colonial Office; not the least, perhaps, in the fact that a number of the forests of the country are under 'working plans' which provide some form of elementary yield control; and even in more or less inaccessible reserves of the Northern Range, which are not yet under working plans, girth limits are in force wherever exploitation takes place. Further, all 'working circles' subjected to concentrated regeneration are governed by working plans. The main factor which is brought about by this position is that the amount of excessive war fellings made during the last seven or eight years will be known and, if necessary, future exploitation regulated in the areas which have suffered, just as is the case in India. This reflects considerable credit on the forest administration of the Colony and the Colonial Government. There are one or two matters, however, in which the Forest Department does not appear as yet to have found itself. It appears to have come to the conclusion that imports of a certain type of forest produce will always be necessary, owing to the fact that exploitation of tropical forest is very costly, and that even the mora forests do not appear to offer great prospects as had once been hoped. On these subjects the report states as follows:

"Whilst the utilisation of local lumber generally has not yet reached the maximum production permissible, for supplies of properly seasoned lumber cut to a variety of standard dimensions, the Colony is dependent upon imports mainly of pitch pine, white pine and douglas fir. No supply of this type of local lumber is available other than small stocks held by furniture makers and private persons for their own use. Adverse factors such as the high cost of exploitation due to low volume production per acre, high loss in conversion of tropical woods, and high cost of labour in relation to skill and output render it unlikely that any such supply from the natural mixed forests could compete with imports. Expert opinion differs as to the economics of intensive exploitation of the mora forests, adverse factors being a high conversion wastage and the refractory nature of mora as a timber. The Colony is likely, therefore, to be dependent upon imports for the higher grade building market until the regenerated forests commence to yield regular supplies of timber at a high rate of volume per acre and consequent low cost of exploitation. Much more intensive exploitation of the forests could, however, be secured by the production of veneers for plywood manufacture. Before this can be undertaken, however, it is necessary to be sure of an adequate supply of raw material, which in turn depends upon how many of the local species will veneer satisfactorily."

In connexion with the introduction of the rotary saw or peeler of the plywood mill into the exploitation of the tropical forest question, it by no means appears necessary that a large percentage of the species of timber in the forest should be capable of peeling; it is not only the veneers from the more valuable tropical species that count, but also the poorer class timbers which are peeled to form the inner sheets; the veneers, of course, only occupying the outside. In any event, testing for peeling purposes of a certain number of the forest species should prove comparatively easy, as they could be sent to the Forest Products Research Station at Princes Risborough, or possibly to one of the United States research institutes. This would appear to be a practical piece of work which should be given early precedence.

Underlying most of the forestry reports from the British Empire at the present time is the recurrent statement stating that the departments are very much under-manned, and that really important work which should be put in hand to secure future progress must be held up until trained staff in sufficient numbers is available.

MUSICAL ACOUSTICS

CONFERENCE AT LIÈGE

IN connexion with the recent celebrations of the centenary of the Faculty of Applied Science of the University of Liège and of the Engineers' Association connected therewith, a conference of persons interested in musical and dramatic acoustics was held during September 4–5 in that city. The sessions were held under the presidency of F. Dacos, and the arrangements were in the hands of F. Monfort. They consisted of five lectures by specialists in various aspects of the subject, followed by general discussions in which both men of science and musicians took part.

M. Fouché (Istambul) dealt with the theory of wind instruments. The natural frequencies of columns of air of various types—pipes with side-holes, partially stopped pipes, etc.—are worked out using the analogy with electrical circuits, the 'end-correction' appearing as a form of radiation resistance. For reed pipes the resonant frequencies of the system, reed plus column of air, are calculated and the results discussed in the light of the intonation of instruments like the clarinet. It was pointed out that these problems date back to some experiments performed by the brothers Weber in 1827.

G. van Esbroeck (Ghent) contributed a paper on the history of musical scales. He pointed out that it is not the ear which has dictated the series of tones which an instrument with fixed notes is made to produce; on the contrary, the tuning of such instruments has conditioned the education of the 'musical ear'. Thus our present scales are based on the Pythagorean tuning of the cithara, a stringed instrument of the ancient Greeks. The demands of key modulation, however, have forced a compromise with just intonation in the form of tempered scales. In the discussion that followed, it was pointed out that singers and players on free-note instruments like the violin use individual scales partly to suit the context or line of music and partly as a result of their musical education.

E. G. Richardson (Newcastle-on-Tyne) outlined the theory of coupled vibrations and of transient phenomena in the production of tone by musical instruments. The action of the hammer on a pianoforte string may be likened to the closing of an inductive switch in a primary electric circuit of which the secondary is a cable. The flute and the flue pipes of organs represent coupled systems in which the exciting member (the edge tone at the mouth) is very strongly damped in comparison with the other (the air column), whereas in an organ reed pipe, and still more in the human voice, the reverse is the case. In the first few milliseconds after the excitation of such a system, transients are set up, the wave form of which may be

quite different to that of the steady state. The lecture was illustrated by oscillograms made by Dr. Richardson and his students.

L. Canac (Marseilles) described his work on the acoustics of open-air theatres. Tests of audibility of nonsense syllables have been made in the Roman theatres of Provence and in open country of similar rising contour. The theatre at Orange, in which the majority of the tests were made, has the stage complete with wall. Contrary to what has formerly been held, this backing wall does not act as a reflector to add intensity to the actor's voice but is so disposed, with much ornamental excrescence, to act as a diffusing screen; in fact, to simulate the conditions of the open air. This was confirmed by experiments on audibility at the theatre of Vaisons, where though the wall behind the stage has not survived, one can now hear better than at Orange, and by laboratory experiments in a model section, using ripples or supersonic beams to exemplify the diffusing properties of the irregular wall surface. Whatever the original intention, the actual function of the backing wall was, in Prof. Canac's opinion, to act as a screen to cut off street noise.

P. Fouché (Paris) gave a general account, from the scientific point of view, of the present state of the study of phonetics. The physicist plays his part by determining the relation between the timbre corresponding to different vowels and the shape and natural frequencies of the buccal cavities. The existence of fixed pitches (*formants*) corresponding to each vowel sound at whatever pitch it may be enunciated is now well established. The physiologist is concerned to measure the muscular effort required to enunciate and to maintain a speech sound—the latter is not constant but diminishes while the physical intensity remains steady. Psychology enters too, for the speaker often has a different 'feeling' for the rate at which he is using energy from that indicated either by muscular measurements or by a microphone measuring physical intensity. M. Fouché urged that the æsthetic aspects of speech should not be ignored. There is a beauty of language as well as a beauty of literature.

This concluded the discussions, but a visit was paid by those taking part in the meetings to the International Exhibition of Scientific Research and Industry, also held to celebrate the centenary, where of special acoustic interest was an electronic model of the ear, built and demonstrated by Dr. Coppée. This consists of a microphone connected through a number of filter circuits (to represent the resonant properties of the inner ear), each terminating in a thyratron and a flash lamp. The latter simulates the property of nerve fibres by which loudness is measured in terms of the *number* of messages passing per second to the brain. Thus, if one holds near the microphone a sounding tuning-fork of a frequency corresponding to that of one of the resonant circuits, the corresponding bulb begins to flash, and flashes become more frequent as the fork is brought nearer. The apparatus shows many other features of the sense of hearing. Gramophone records of music heard through the ear of a cat were also played.

At the final session, it was unanimously agreed that those present should form the nucleus of an international conference on acoustics generally, which should be called together every few years and held in a number of European centres in succession. The honorary liaison secretary for this purpose is M. F. Monfort, jun., 32 rue de France, Verviers, Belgium.

DANISH MARINE BOTTOM INVERTEBRATES

A RECENTLY published handsome volume*, dedicated to the memory of C. G. J. Petersen, director of the Danish Biological Station for many years, is in the best tradition of Danish oceanographical research, and is a tribute to the undaunted temper of the Danish people, who kept alive the spirit of learning, although surrounded by their enemies.

Petersen and Boysen Jensen had published during 1911–15 their "Animal Communities of the Sea Bottom", dealing with the charting of the fauna of the ocean bed from the Baltic to the Skagerrak by means of the newly invented Petersen grab. It was intended to follow this up by a study of the breeding habits and young of the bottom communities in relation to their importance as food for fishes, but between the Wars attention was diverted to investigations on the fish themselves. Dr. Thorson and his collaborators, many of them well known in the zoological world, began in 1936 an intensive study of the Danish marine fauna, but, "instead of concentrating on the young bottom stages", as Petersen did, have attempted "to trace the species back to the planktonic larval stages". It is here that our knowledge was deficient, yet research from the faunistic, economic or ecological points of view necessitates recognition of the species to which the pelagic larvæ belong. Despite the painstaking work of Mortensen on larval Echinoderms, Lebour on Molluscs and Crustacea and D. P. Wilson on Polychætes, most of us get no further than identifying an *Auricularia* larva, a Nudibranch egg ribbon, a zoœa larva or a Spionid metatrochophore. At first, then, much of Dr. Thorson's work was analytical. He must either rear the larvæ from eggs, as has been done so successfully at Plymouth, or trace the stages back to younger and younger larvæ, sketching every 'unknown' alive, in the hope that some day its place in the series will be found and its parents determined. Since these early stages are so sensitive to their environment, it is important to collect them in their own water, and to record temperature, light intensity, salinity, *p*H, food conditions and enemies. When all this has been done a synthesis from an ecological point of view can be attempted, involving all stages in the life of the animal and its community. "The whole survey," writes Dr. Thorson, "has been carried out in our leisure hours, and enabled us to combine the scientific work with splendid summer holidays."

The plan of campaign was to take vertical plankton hauls at metre intervals, from near the bottom to the surface, in fixed localities, every fortnight throughout the year. Two main sites were chosen, one off the island of Ven (Swedish) and the other at Helsingør (Danish). The former was used until 1941, after which date, owing to the War, the work was transferred to the Danish station. The net hauls were examined as soon as possible by a team of workers sorting, counting, sketching, recording and, if possible, identifying the species of animals. During the summer pump hauls were taken by pumping 200 (later 100) litres through a No. 12 plankton sieve, starting a few centimetres above the bottom, and repeating at metre intervals, so that nineteen samples were taken

* Meddelelser fra Kommissionen for Danmarks Fiskeri- og Havundersøgelser. Serie: Plankton. Bind 4. No. 1. Gunnar Thorson: Reproduction and Larval Development of Danish Marine Bottom Invertebrates, with special reference to the Planktonic Larvæ in the Sound (Øresund). Pp. 523+199 plates. (København: C. A. Reitzels Forlag, 1946.)

from the 20-metre depth of water. The advantage of this procedure was that the individual samples were transported to the laboratory in water from their own depths. Rearing of the larval stages was carried out in aquaria in the laboratory, and by means of 'bottle collectors' invented for the purpose. These were left submerged in the open sea, at the depth to which certain organisms were accustomed, for six weeks at a time, and then hauled up for inspection. The cage collectors used by Smith in Great Britain were found unsuitable owing to variations in temperature and salinity in Danish waters. The bottle collector is like an inverted bell jar, with a stopper at the lower end, protected at the sides by a jacket of pieces of cork held together by netting. It is anchored by stones to the required depth, and is marked by a float on the surface. This open apparatus collects its own sea bed for the delicate larvæ, from the rain of detritus from above, and experience shows that the larvæ are closely adapted to suitable surroundings, dying rather than metamorphosing if the right substratum is not available. The water in the bottle collects the swimming stages. Moreover, after being hauled up, the bottles can be placed on racks and kept as small aquaria. In one locality young bottom stages of seventy invertebrates were secured at a depth of 16 m.

The results of these investigations showed that the dominant groups in the Sound plankton are Lamellibranchs (57·3 per cent), Prosobranchs (12·5 per cent), Polychætes (10·9 per cent) and Echinoderms (1·9 per cent). There is a high percentage of Cyphonautes larvæ (12·9 per cent), leaving only 4·5 per cent for all other groups.

Dr. C. B. Jørgensen contributes the section on Lamellibranch larvæ, and was able to identify twenty-three species, the most interesting of which were those of *Teredo* and the two species of *Montacuta*. Sixty-one Prosobranchs are known in the larval stage, and of these sixty have a long pelagic life. They are mostly phytotrophic and form the food of herring, mackerel and many invertebrates. About half the 142 species of bottom Polychætes can be identified in the larval stage, and their success in evading capture by predaceous animals is due to their armour of bristles. Many feed on the larvæ of Lamellibranchs. The percentage of Echinoderm larvæ appears small, until it is realized that these well-known larvæ cannot endure changes in salinity and temperature, and having no hydrostatic apparatus are unable to adjust themselves in depth when an infiltration of less saline waters from the Baltic floods the upper waters of the Sound. Dr. Mortensen considers that the parent stock on the bottom is recruited, not from the larvæ in the Sound itself, but from the large swarms of the Kattegat. He found also that the reproductive-rate of these migrants was less in the new habitat. This relation between spawning, larval survival and ecological conditions might be followed up around the shores of Britain in an attempt to explain anomalies of distribution.

Two life-histories that are of special interest are those of *Philine aperta* and the Holothurian *Psolus phantopus*.

In the final discussion many valuable generalizations emerge. Evidence goes to show that the larvæ are evenly distributed through the water masses, rarely swarming. In two years only three larvæ of *Strongylocentrotus dræbachiensis* were collected. Is this species, therefore, rare? Yet, if evenly distributed, there would be two and a half milliards in the area. What, then, must be the population of 'common' forms? Dr. Thorson works out that *Littorina littorea* would have twelve thousand milliard and *Mytilus edulis* four thousand five hundred milliard larvæ.

The distribution of the larvæ throughout the year enables one to work back to the spawning periods. July has the maximum for all types of larvæ in the Sound, but there are lesser peaks in spring and winter. The minimum is in the late autumn. Compared with fjord conditions, spawning is spread over a long period, not concentrated into a late spring and early summer peak as in the fjords. In the Sound there is a drift of larvæ from the Baltic northwards to the Kattegat, bringing impoverished specimens from the less saline waters. The reverse stream, from the Kattegat southwards, is much richer in individuals. There are also the larvæ developing from the spawn of animals living on the bottom. Analysing these three sources, Thorson found that the Baltic stream from May onwards brings chiefly the larvæ of *Littorina littorea* and other Prosobranchs, the bottom fauna of the Sound produces non-pelagic larvæ or larvæ with a short pelagic life (for example, *Serpula*), and the parents in the Kattegat provide 50 per cent or more of the whole stock in the Sound, mostly larvæ with a long pelagic life. As an ecological area, therefore, the Sound supplies very different data from those obtainable in either arctic or tropical regions, where the larvæ have mostly a short pelagic life; and in the temperate zone it is the high proportion of larvæ with a long pelagic life which provides food for the fishes of economic importance. Moreover, this is the group that shows the greatest fluctuation in numbers from year to year.

To sum up, Dr. Thorson's book is a valuable contribution to both analytical and synthetic aspects of the fauna of a marine area. We in Britain can learn much from his work and his methods, and not by any means least from his clear, smoothly flowing English and delicate, accurate drawings.

There is a summary at the end of each section, and the final summary is printed also in Danish. An exhaustive bibliography and index are appended. The book is well produced and printed, but its limp covers will soon need replacement in libraries.

N. B. Eales

FORTHCOMING EVENTS

Monday, December 1

Royal Society (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Anniversary Meeting.

Tuesday, December 2

Society of Dyers and Colourists, Scottish Section (at St. Enoch Hotel, Glasgow), at 7 p.m.—Dr. K. W. Richmond: "Modern Trends in Hydrogen Peroxide Application".

Society of Dyers and Colourists, Huddersfield Section (joint meeting with the Royal Institute of Chemistry, at Field's Café, Westgate, Huddersfield), at 7.30 p.m.—Dr. W. Baird: "Modern Developments in Synthetic Detergents".

Wednesday, December 3

Physical Society, Colour Group (in the Lecture Theatre of the Geological Museum, Exhibition Road, London, S.W.7), at 3.30 p.m.—Mr. J. Pryce-Jones: "Ultramarine—Natural and Synthetic".

Hispanic and Luso Brazilian Councils (at Canning House, 4 Upper Berkeley Street, London, W.1), at 5 p.m.—Mr. Kenneth G. Grubb: "The Great British Explorers of the Interior of South America".

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. T. C. Macnamara, Mr. A. B. Howe and Mr. P. A. T. Bevan: "The Design and Operation of High-Power Broadcast Transmitter Units with their Outputs Combined in Parallel".

Manchester Statistical Society (at the Reform Club, King Street, Manchester), at 5.30 p.m.—Dr. George Gibson: "Modern Distribution of Industrial Activity in the North-West Region".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (joint meeting with the FOOD GROUP OF THE SOCIETY OF CHEMICAL INDUSTRY, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Discussion on "The Occurrence, Physiological Importance and Estimation of Metallic Contaminants in Foodstuffs".

Thursday, December 4

CHEMICAL SOCIETY, SHEFFIELD SECTION (joint meeting with the SHEFFIELD UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. G. R. Clemo, F.R.S.: "The Bearing of the Isotopes of Carbon, Hydrogen, Oxygen and Nitrogen on Organic Chemistry".

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting with the ACOUSTICS GROUP OF THE PHYSICAL SOCIETY, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. W. G. Radley: "Speech Communication under Conditions of Deafness or Loud Noise".

CHEMICAL SOCIETY, NOTTINGHAM SECTION (in the Chemistry Lecture Theatre, University College, Nottingham), at 6 p.m.—Scientific Papers.

ILLUMINATING ENGINEERING SOCIETY, MANCHESTER CENTRE (in the Reynolds Hall, College of Technology, Manchester), at 6 p.m.—Mr. W. Imrie-Smith: "Industrial Lighting".

INSTITUTION OF MECHANICAL ENGINEERS, GRADUATES' SECTION (at Storey's Gate, St. James's Park, London, S.W.1), at 6.30 p.m.—Mr. K. M. Fantom: "Electronics for the Mechanical Engineer"

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Sir Ian Heilbron, F.R.S.: "Recent Developments in the Vitamin A Field" (Pedler Lecture).

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (joint meeting with the BRISTOL SECTION of the SOCIETY OF CHEMICAL INDUSTRY, at Bristol).—Mr. A. Forster and co-authors: "The Manufacture of Tetryl by Continuous Nitration".

Friday, December 5

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Economics of Metering" (to be opened by Mr. M. Whitehead).

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. E. A. Watson: "Fuel and Combustion Systems for the Aero Gas Turbine".

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Prof. D. M. S. Watson, F.R.S.: "Fossilization".

ROYAL STATISTICAL SOCIETY, INDUSTRIAL APPLICATIONS SECTION (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. E. C. Fieller: "The Mathematics Division of the National Physical Laboratory, with particular reference to Statistical Methods".

SOCIETY OF CHEMICAL INDUSTRY, MANCHESTER SECTION (joint meeting with the LOCAL SECTIONS of the CHEMICAL SOCIETY and the ROYAL INSTITUTE OF CHEMISTRY, in the Lecture Hall, Albert Hall, Manchester), at 6.30 p.m.—Sir Wallace Akers: "Industrial Uses of Atomic Energy".

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL GROUP (in the Society of Architects' Room, Textile Institute, 16 St. Mary's Parsonage, Manchester), at 6.45 p.m.—Mr. J. Morley: "Some Statistical Experiments in the Steel Industry".

SOCIETY OF INSTRUMENT TECHNOLOGY, MIDLAND SECTION (at the Chamber of Commerce Buildings, New Street, Birmingham), at 7 p.m.—Mr. V. A. Hughes: "Some Examples of Instrumentation in Modern Research".

Saturday, December 6

BRITISH MYCOLOGICAL SOCIETY (at the Linnean Society of London, Burlington House, Piccadilly, London, W.1), at 12 noon.—Annual Meeting; at 2 p.m.—Prof. C. G. C. Chesters: "Concerning Fungi Inhabiting the Soil" (Presidential Address).

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the University, Reading), at 3 p.m.—Prof. E. A. Guggenheim, F.R.S.: "The Atomic Nucleus".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT IN THE CHEMISTRY DEPARTMENT—The Secretary, Royal (Dick) Veterinary College, Summerhall, Edinburgh 9 (December 1).

ASSISTANT LABORATORY TECHNICIAN IN THE HISTOLOGICAL LABORATORY—The Registrar, The University, Liverpool (December 6).

CHEMICAL PATHOLOGIST in the Department of Pathology and Bacteriology—The Secretary, Welsh National School of Medicine, 10 The Parade, Cardiff (December 6).

TECHNICAL ASSISTANTS IN THE PASTURE RESEARCH BRANCH of the Department of Agriculture and Lands—The Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (December 10).

ADVISORY OFFICER IN CROP HUSBANDRY—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (December 12).

ALGOLOGIST (Scientific Officer) at the Millport Laboratory—The Secretary, Scottish Marine Biological Association, 185 St. Vincent Street, Glasgow, C.2 (December 13).

SENIOR PHYSICIST with experience in textile research, a SENIOR ORGANIC CHEMIST with experience in textile research, a PHYSICIST with research experience, though not necessarily in textiles, and a CHEMIST for physical chemical research—The Director of Research, British Jute Trade Research Association, Bellfield Street, Dundee (December 20).

JUNIOR OBSERVER—The Director, The Observatories, Cambridge (December 20).

ASSISTANT POMOLOGIST, and an ASSISTANT PLANT PHYSIOLOGIST, at the Long Ashton Research Station—The Secretary and Registrar, The University, Bristol (December 27).

NATURALIST at the Dove Marine Laboratory—The Registrar, King's College, Newcastle-upon-Tyne (December 31).

TRAVIS RESEARCH FELLOWSHIP IN BACTERIAL METABOLISM in the Medical School, University of Otago—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (Otago, December 31).

RESEARCH FELLOWSHIP for the study of properties of natural and synthetic fibres—The Registrar, The University, Leeds 2 (January 1).

HEAD OF THE APPLIED NUTRITION DEPARTMENT—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire (January 3).

ASSISTANT LECTURER (Grade III) FOR THE DEPARTMENT OF BREWING AND INDUSTRIAL FERMENTATION—The Secretary, The University, Edmund Street, Birmingham 3 (January 12).

PROFESSOR OF PHYSIOLOGY—The Secretary, Queen's University, Belfast (January 17).

LECTURER IN DIPLOMA MATHEMATICS (Post Matric. standard), a LECTURER IN PHYSICAL, ORGANIC, INORGANIC AND INDUSTRIAL CHEMISTRY and CHEMICAL ENGINEERING, a LECTURER IN DIPLOMA PHYSICS (Post Matric. standard), a LECTURER IN ELECTRICAL ENGINEERING, a LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN CIVIL ENGINEERING, in the Technical Education Branch of the Department of Public Instruction of New South Wales—The Official Secretary, New South Wales Government Offices, 56–57 Strand, London, W.C.2 (January 25).

ASSISTANT DIRECTOR, Royal Botanic Gardens, Kew—The Secretary, Ministry of Agriculture and Fisheries, 23–25 Soho Square, London, W.1 (January 31).

LECTURER IN GEOLOGY—The Registrar, University College, Hull (January 31).

ASSAYER OR CHEMIST with special experience in the analysis of non-metallic and metalliferous minerals—The Secretary, Mianral, Teoranta, Four Provinces House, Harcourt Street, Dublin.

LECTURER IN HISTOLOGY and a LECTURER IN BIOCHEMISTRY—The Registrar, King's College, Newcastle-upon-Tyne.

ASSISTANT CHIEF PHARMACIST by the Government of Malayan Union for Medical Department, Singapore—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18288.

RESEARCH WORKER (Junior, temporary) IN CHEMOTHERAPY AND TROPICAL MEDICINE at the National Institute for Medical Research—The Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

METALLURGIST by the Ceylon Government for the Department of Commerce and Industries—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N. 14681.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Rubber Producers' Research Association. Publication No. 75: Dielectric Relaxation and Viscosity of Long-Chain Dipolar Liquids. By Adolf Schallamach. Pp. 14. Publication No. 77: A Differential Fourier Method for Refining Atomic Parameters in Crystal Structure Analysis. By A. D. Booth. Pp. 6. Publication No. 78: The Accuracy of Atomic Co-ordinates derived from Fourier Series in X-Ray Structure Analysis. By A. D. Booth. Pp. 16. (London: British Rubber Producers' Research Association, 1946.) [213

Imperial Institute. Annual Report, 1946, by the Director, Sir Harry Lindsay, to the Board of Governors. Pp. 80. (London: Imperial Institute, 1947.) [94

Imperial Cancer Research Fund. Forty-fourth Annual Report, 1946–1947. Pp. 36. (London: Imperial Cancer Research Fund, 1947.) [94

Other Countries

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 197: The Analysis of the Hydrocarbon Gases by Fractional Distillation, with especial reference to Cracked Tar Gases. By R. J. L. Martin. Pp. 36 + 4 plates. (Melbourne: Government Printer, 1946.) [213

Journal de la Société des Océanistes. Tome 1, No. 1, Décembre. Pp. 234. (Paris: Musée de l'Homme, 1946.) 300 francs. [213

Astrographic Catalogue 1900·0. Sydney Section. Dec. −51° to −65°, from Photographs taken at the Sydney Observatory, New South Wales, Australia. Vol. 18, with Plate Constants for Vols. 21 to 24: R.A. 6h to 12h, Dec. −55° to −57°, Plate Centres Dec. −56°. Pp. viii + 119. Vol. 20: R.A. 18h to 24h, Dec. −55° to −57°. Plate Centres Dec. −56°. Pp. iv + 33. (Sydney: Government Printer, 1946.) [213

Report of the Secretary of the Smithsonian Institution and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1946. (Publication 3864.) Pp. ix + 134. (Washington, D.C.: Government Printing Office, 1946.) 35 cents. [213

Smithsonian Miscellaneous Collections. Vol. 106, No. 15: Ladybeetles of the Genus *Epilachna* (Sens. Lat.) in Asia, Europe and Australia. By G. H. Dieke. (Publication 3860.) Pp. iii + 183 + 27 plates. (Washington, D.C.: Smithsonian Institution, 1947.) [213

Smithsonian Institution: United States National Museum. Bulletin 50: The Birds of North and Middle America. Commenced by the late Robert Ridgway, continued by Herbert Friedmann. Part 10. Pp. xii + 484. (Washington, D.C.: Government Printing Office, 1946.) 1.25 dollars. [213